550/555 SPECTRORADIOMETER SYSTEM

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550/555 SPECTRORADIOMETER SYSTEM

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ADDENDA No. 1

Model 550/555 Spectroradiometer System
Instruction Manual

1. The manual monochromator system which formerly consisted of the 555-61 monochromator and 555-62 filter wheel is now designated as the 555-61M monochromator assembly.
2. The automatic system which included the 555-64 and 555-65 filter wheel and wavelength drive assemblies in addition to the 555-61 and 555-62 is now designated as the 555-61A monochromator assembly. The specific nomenclature markings for the 555-62, 555-64, and 555-65 have been eliminated on the actual hardware.
3. A change has been made to the design and manufacture of the automatic 555-61A monochromator assembly.
   A. The wavelength potentiometer has been enclosed by an expanded cover and is accessed via two BNC connectors. This more easily facilitates the plotting of wavelength vs. intensity on a chart recorder.
   B. The cable connector for the automatic drive as well as the BNC connectors for the analog wavelength plot have been moved to the same side of the monochromator as the detector head, thereby allowing all connecting cables to exit from <u>one</u> side of the system.
   C. The drive motors have been replaced with heavier duty motors. When the 555-66 Controller is not connected, or when it's power is off, the wavelength may still be adjusted manually. In this case, the wavelength control dial should turn more smoothly than before. However, when the power to the 555-66 Controller is ON, the wavelength control dial will be very difficult to adjust. To overcome this problem, a clutch has been added to the system. It is accessed by a button located near the automatic drive cable connector on the side of the monochromator. This button should be kept depressed to allow easy <u>manual</u> wavelength selection and adjustment when the 555-66 Controller is connected to the 555-61A and has the power ON.

MODEL 550/555 SPECTRORADIOMETER

ADDENDUM TO INSTRUCTIONS No. 2

Effective September 1, 1981 there has been a change made in the selection of order sorting filters used in the Filter Wheel/Input Optics to the 555-61 Monochromator. This change has been made to allow for better accuracy at the cross-over wavelengths where it is necessary to change filters. If you receive a new Model 555-61 Monochromator after September 1, 1981, or if you return your system to the factory for recalibration after that date, then you should carefully note in your new calibration data the wavelengths at which the order sorting filters should be changed.

According to Page 7 of the Instruction Manual the OLD wavelength regions were:

Order Sorting Filters

Filter Code	Wavelength Region
.	280-350 nm
. .	350-400 nm
. . .	400-600 nm
. . . .	600-1100 nm

For any new or factory-recalibrated system received after September 1, 1981 the NEW wavelength regions are:

Order Sorting Filters

Filter Code	Wavelength Region
.	280-360 nm
. .	360-420 nm
. . .	420-600 nm
. . . .	600-1100 nm

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MODEL 555 SPECTRORADIOMETER SYSTEM

The Model 555 Spectroradiometer System integrates all the state-of-the-art features of the Model 550 Radiometer/Photometer with the precision and accuracy of the Model 555-61 Monochromator to yield a compact, light weight, high efficiency measurement system. The Model 555 is capable of providing spectral measurements of both continuous and pulsed sources over the spectral range of 200 nm to 1100 nm. Due to excessive scattered radiation below 280 nm when a tungsten lamp is measured with a silicon detector, the standard system is normally only calibrated over the range of 280-1100 nm. If the system is intended for use with sources other than tungsten, such as deuterium or mercury sources, then a different order sorting filter can be used for the ultraviolet region which permits calibration down to at least 250 nm.

The basic Model 555 Spectroradiometer (Figure 1) consists of the following components:

Model 550-1 Digital Radiometer/Photometer
Model 550-2 Type A Silicon Multiprobe (Visible-IR)
Model 555-61 Monochromator Assembly
Model 555-62 Filter Wheel

The basic manual system can be expanded into an automatic measurement system with selectable wavelength scan ranges, scan speeds, automatic order sorting filter sequencing, and interface compatibility for automatic data printout.

The following components are available for the automatic Model 555 Spectroradiometer System (Figure 2):

Model 555-64 Filter Wheel Drive Assembly
Model 555-65 Wavelength Drive Assembly
Model 555-66 Wavelength Control Module
Model 555-67 Data Controller
Model 550-9 BCD Output for Model 550-1 Radiometer/Photometer

The following optional accessories are available for use in either the manual or the automatic system:

Model 550-2 Type B Silicon Multiprobe (UV-Visible-IR)
Model 550-3 Pulse Integration Module (manual only)
Model 555-20 Automatic Data Reduction Program for HP9815A Calculator
Model 555-30 Power Supply
Model 555-32 High Sensitivity Detector Head (S-20)
Model 555-68-1 Fixed Slits for 1.0 nm bandwidth
Model 555-68-2 Fixed Slits for 2.0 nm bandwidth
Model 555-68-5 Fixed Slits for 5.0 nm bandwidth
Model 555-68-20 Fixed Slits for 20.0 nm bandwidth
Model 555-70 Fiber Optics Probe
Model 555-71 End-On Viewing Head
Model 555-72 Side Viewing Head
Model 555-73-5 5 Degree Field of View Adapter

A functional block diagram of the complete Model 555 Automatic Scanning Spectroradiometer is shown in Figure 3. The sensitivity and minimum/maximum spectral irradiance levels that the system is capable of measuring are shown in Figure 4.

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SPECIFICATIONS

Spectral Range:	200-1100 nm without grating change
Calibration Range:	280-1100 nm (due to scattered radiation below 280 nm)
Dispersion:	12 nm/mm
Standard Slit Width:	10 nm
Optional Slit Widths:	1, 2, 5 & 20 nm
Wavelength Accuracy:	±2 nm 200-1100 nm ±1.0 nm 380-760 nm
Wavelength Repeatability:	±0.5 nm
Scattered Light (Worse Case Tungsten Source and 550-2 Silicon Detector)	280-300 nm ≤ 3.0% 300-600 nm ≤ 0.6% 600-1100 nm ≤ 0.3%
Order Sorting Filters:	Four filters, wheel mounted
Length X Width X Height:	8" x 6" x 3.5" (20 x15 x 9 cm)
Weight:	6 pounds (2.8 kg)

DESCRIPTION OF
BASIC SPECTRORADIOMETER SYSTEM

1. Model 550-1 Digital Radiometer/Photometer.

The Model 550-1 Radiometer/Photometer is described in detail in the Model 550 Instruction Manual. When used in the Model 555 Spectroradiometer System, the Unit Selector switch should be set either to nanoamps (cw) or nanocoulombs (pulsed).

2. Model 550-2 Multiprobe Detector.

The Model 550-2 Multiprobe Detector, described in the Model 550 Instruction Manual, threads onto the exit slit housing of the Model 555-61 in a rigid repeatable position. When used in the Spectroradiometer system the six-position switch on the rear of the Multiprobe should be set to position 1. Only the detector head itself is threaded onto the monochrometer, never with either of the radiometric or photometric filters.

3. Model 555-61 Monochromator Assembly

The Model 555-61 Monochromator (Figure 5) utilizes a specially designed F/3.5 concave holographic grating which covers the spectral region 200-1100 nm while optimizing grating efficiency and minimizing scattered light. The optical schematic of the monochromator is shown in Figure 6 along with the input optics for this system.

The light source to be measured is set up on the axis of the system such that the angular subtense of the source is 10° or less as seen from the diffusers. Alternatively, a point source located anywhere within this 10° cone will produce a uniform output to within 3%. The collector lens images the diffuser onto the grating, such that the position of the diffuser imaged on the grating is independent of the source location in the field of view.

The concave holographic grating, acting both as a dispersive element and a focusing lens, spectrally disperses the light and focuses it onto the exit slit. The entrance slit, not the source or the diffuser is imaged onto the exit slit. The bandpass of the system is the product of the exit slit width and the grating dispersion (12 nm/mm). For example, if the system is being used with the Model 585-68-10 slits which are 0.833 mm wide, the bandpass is (.833 mm) (12 nm/mm) = 10 nm. Conversely, if a 1 nm measurement bandpass is desired, the required slit width is (1 nm)/(12 nm/mm) = .0833 mm.

The wavelength presented at the exit slit is changed by rotating the grating. A four digit wavelength display that is mechanically coupled to the grating drive shaft provides a direct, accurate wavelength readout in nanometers. The accuracy of the wavelength setting is better than ±2 nm over the entire range of 200-1100 nm and ± 1.0 nm over the visible spectral region of 380-760 nm. The repeatability of the wavelength setting is better than ±0.5 nm. The minimum reading graduation is 0.2 nm.

When the manual monochromator system is used without the Model 555-65 Wavelength Drive Assembly, the grating may be turned very easily and smoothly by rotating the knob which is located just below the wavelength counter. However, when the 555-65 Wavelength Drive Assembly is connected to the monochromator, this knob is slightly more difficult and not quite as smooth to manually rotate, as a slip-clutch in the motor assembly must be overcome.

CAUTION:

If the grating drive shaft or wavelength counter assembly should bind-up, the knob will not be able to be rotated at all. In this case consult troubleshooting chart on Page _____.

A ten turn potentiometer, which is located on the opposite side of the monochromator assembly from the wavelength readout, is mechanically coupled to the grating drive shaft. This potentiometer should be connected to a +5 VDC supply. It then provides an analog voltage that is directly proportional to the wavelength setting for driving an X-Y recorder. When the Model 555-66 Wavelength Control Module is used, a 5 VDC power supply is contained within the module and may be accessed by the BNC connector on the rear panel to provide 5 volts to the wavelength potentiometer.

A threaded hole which accomodates an M-8 post, is provided in the bottom of the Monochromator Assembly so that the unit can be mounted on an optical bench.

4. Model 555-62 Filter Wheel

Four order sorting filters which are used to eliminate the higher order wavelengths produced by the grating in the Model 555-61 Monochromator are permanently mounted in the Model 555-62 Filter Wheel Assembly. This assembly is attached directly to the front of the monochromator housing. The filters are coded with a series of white dots. The filter code and the wavelength range of each filter are given in the table below.

Order Sorting Filters

Filter Code	Wavelength Region
.	280-350 nm
. .	350-400 nm
. . .	400-600 nm
. . . .	600-1100 nm

Order sorting filters are required because a grating produces a multiple ordered spectrum. In simple terms the angular location of a given wavelength is given by:

$\theta = \pm n \lambda d$

where θ = angular position of a given line

$n = 0, \pm 1, \pm 2$, etc.; order of spectrum

λ = wavelength

d = linear position of a given line

For a fixed θ and d a number of lines will occur at the same position as long as the $n\lambda$ product remains constant. For example, if the grating is set to 1000 nm the following wavelengths will be superimposed at the image plane:

1000 nm	1st order	1 (1000) = 1000
500 nm	2nd order	2 (500) = 1000
333 nm	3rd order	3 (333) = 1000
250 nm	4th order	4 (250) = 1000
200 nm	5th order	5 (200) = 1000

etc.

Therefore, in order to make a proper measurement at 1000 nm these other wavelengths will have to be filtered out. A filter which transmits the first order and absorbs higher orders (i.e. an order sorting filter) is used for this purpose.

The proper order sorting filter is easily put in place by manually rotating the filter wheel until the filter code desired is visible at the top of the wheel and the two white lines on the assembly are matched-up. For example, when the four dot filter code is visible at the top, the proper order sorting filter for the spectral region 600-1100 nm will be in position behind the input diffuser in the filter wheel assembly. When the optional Model 555-64 Filter Drive Assembly is used, the filter wheel assembly may be slightly difficult to rotate since the slip-clutch of the motor assembly must be overcome. When the motor drive assembly is not attached to the monochromator (i.e. the manual system), the filter wheel assembly turns very freely and alignment of the white lines is aided by detent positioning stops.

Figures 7a and 7b which are spectrum scans of a low pressure mercury lamp done with and without order sorting filters illustrate the importance of using proper order sorting filters.

5. Model 555-68 Series Slits (Optional Accessories)

The Model 555-68 Series Slits permit spectral measurements to be made at four selected bandwidths of 1, 2, 5, and 20 nm. Each set contains an entrance and an exit slit with the bandwidth clearly marked on each slit. The

slits are interchangeable with respect to which is the entrance slit and which is the exit slit, and are easily installed by sliding out the old slits and sliding in the new set. A small screwdriver or any small thin instrument may be inserted below the button on the face of the slits and a slight upwards pressure will slide the slit out of its holder.

Model 555-68-1: 1 nm slits
Model 555-68-2: 2 nm slits
Model 555-68-5: 5 nm slits
Model 555-68-20: 20 nm slits

The Model 555-68-10 slits for a fixed bandwidth of 10 nm are supplied as part of the 555-61 Monochromator

6. Model 555-30 Series of PMT Detector Heads.

The Model 555-30 Series of PMT Detector Heads are used with the Model 550/555 Spectroradiometer to enable absolute measurements of low intensity, pulsed or CW, light levels. These Detector Heads incorporate photomultiplier tubes to provide approximately four decades of additional sensitivity over that furnished by the Model 550-2 Series of Silicon Detector Heads. The three Detector Heads available are listed in the Table below along with the spectral range encompassed by each head.

	Model 555-32	Model 555-34	Model 555-35
Spectral Range	280-800nm	200-400nm Solar Blind	280-900nm

The basic Model 550/555 Spectroradiometer System utilizing the Model 555-30 Series of PMT Detector Heads consists of the following components:

Model 550-1	Indicator Unit
Model 555-30	Series of Detector Head (555-32, 34, or 35)
Model 555-30	PMT Power Supply
Model 555-61	Monochromator
Model 555-62	Filter Wheel/Input Optics
Model 555-68-10	Fixed Slits

The PMT Detector Heads can also be used as a radiometer or a photometer. In this configuration, either opal glass (visible and IR) or ground quartz (UV and visible) is threaded into the front of the detector, and the monochromator is omitted.

Energy and average power measurements with the PMT Detector Head configuration are obtained directly from the multi-decade meter of the Model 550-1 Indicator Unit, from an external recorder, or from an oscilloscope. Applications with the PMT Detector Head configurations include measurement of phosphors, chemical reactions, electroluminescence, emissivity and reflectivity of surfaces, biochemical analysis, and other low-level signal analysis.

Consistent with the Model 550/555 Spectroradiometer concept of convenience, the Model 555-30 Series of Detector Heads have the quick-connect capability of threading directly onto the Model 555-61 Monochromator in place of the Model 550 Series of Silicon Detector Heads, and ensure optimum optical coupling throughout the system. In addition, their small size and light weight are consistent with the easy portability of the Model 550/555 System. The system has been designed so that the output beam

of the Monochromator will just underfill the active area of the PMT cathode surface, thereby producing maximum utilization of all incident light. The Detector Heads incorporate a safety shutter to prevent possible damage to the photomultiplier tube (PMT) in the event that the user inadvertently disconnects the Detector Head from the Monochromator without first turning off the PMT power.

To provide a quick, convenient method of PMT gain calibration, an internal reference source has been included in each Model 555-30 Series Detector Head. Power for this source is derived from the Model 555-30 Power Supply. The Model 555-30 Power Supply is used with all of the Model 555-30 Series of PMT Detector Heads. The power supply - detector head combination provides facility for controlling the PMT operating voltage, thereby regulating the photomultiplier gain and preserving the calibration of the overall system.

AUTOMATIC SPECTRORADIOMETER SYSTEM

1. Model 555-64 Filter Wheel Drive Assembly

The Model 555-64 Filter Wheel Drive Assembly attaches to the Model 555-62 Filter Wheel and inserts the proper order sorting filter into the optical path on command from the Model 555-66 Wavelength Control Module. The time required for each filter change is 0.0228 min. The Filter Wheel Drive Assembly mounts onto the side of the monochromator housing.

2. Model 555-65 Wavelength Drive Assembly

The Model 555-65 Wavelength Drive Assembly attaches to the grating drive shaft and drives the grating through preselected wavelength ranges at various scan sppeds on command from the Model 555-66 Wavelength Control Module. The Wavelength Drive Assembly mounts onto the side of the monochromator housing.

3. Model 555-66 Wavelength Control Module

The Model 555-66 Wavelength Control Module (Figure 8) controls the automatic operation of the Model 555 Spectroradiometer System. The Model 555-66 allows the user to program the desired wavelength scan range and scan speed, the wavelength intervals for order sorting filter sequencing, and the selection of single or multiple scan cycles. The Model 555-66 also contains provision for remote operation of Model 555 Spectroradiometer System, as well as an internal +5 Volt DC supply which may be used to power the monochromator wavelength potentiometer for wavelength analog output.

Model 555-66 Characteristics

λ SCAN INTERVAL (NM): Three digit thumbwheel switch (lowest digit is fixed at 0) used to select the wavelength interval through which the monochromator will scan above initial manual setting of monochromator wavelength. For example, if monochromator wavelength is initially set (manually) at 350 nm and the λ SCAN INTERVAL switch is set to 650, the monochromator will scan from 350 nm to 1000 nm.

FILTER λ INCREMENTS (NM): Three independent thumbwheel switches (lowest digit is fixed at 0) which select the wavelength increment above the initial manual wavelength setting at which a trip level sequences the next filter into position. These trip levels, however, are independent of the right to left order of the switches depending only on the absolute value of the numbers. For example, if the initial manual wavelength setting is 280 nm and the FILTER λ INCREMENT switches are set at 70, 120, 320, the filters will be sequenced at 350 nm, 400 nm and 600 nm. Likewise, if the FILTER λ INCREMENT switches are set at 120, 320, 70, the filters will still be sequenced at 350 nm, 400 nm and 600 nm.

λ DRIVE SPEED (NM/MIN): Five interlocking pushbutton switches which select the scan speed. The five speed settings available are 400, 200, 100, 50 and 25 nm/Min. These correspond to actual scanning speeds of 444, 222, 111, 55, and 28 nm/mm. The drive speed can be changed during a scan by depressing the HOLD/RELEASE switch, changing the scan speed switch, and then releasing the HOLD/RELEASE switch to resume the scan at the new speed.

λ DRIVE CONTROL: Three interlocking pushbutton switches each of which selects a different mode of wavelength scan drive.

SINGLE: Scans at a selected speed from the initial wavelength setting through the scan interval, returns to the initial setting and then stops.

CYCLE: Scans continuously in both directions at the selected scan speed through the selected scan interval.

MULTIPLE: Scans at the selected drive speed from the initial wavelength setting through the scan interval, and then returns at maximum drive speed (400 nm/min.), and repeats continuously.

START/STOP: Latched pushbutton switch which controls initialization of the scan.

START:
Switch depressed. All control logic is reset and scanning is initiated.

STOP:
Switch released. All operations stop and manual resetting of initial wavelength setting is required.

NOTE: If the START/STOP switch is released during scanning, the motor will stop and all control logic will be reset to zero, making the new initial wavelength setting the wavelength at which the interruption occurred just as if the instrument has been set manually to that wavelength. This will also occur if the power is interrupted during a scan. When the pushbutton is depressed the system will continue to scan but all increments will now apply to the new wavelength reference. For example, if the initial wavelength setting had been 280 nm and if the filter sequencing increments were set at 70, 120 and 320 respectively, and the scan interval set at 720, the filters under normal operation would sequence at 350, 400 and 600 nm and the scan would be completed at 1000 nm. However, if for some reason the START/STOP switch were depressed during the scan, say at 300 nm

and then released, the filters would then sequence at 370, 420 and 620 nm and the scan would be completed at 1020 nm.

HOLD/RELEASE: Latched pushbutton switch which allows a scan to be interrupted without the control logic being reset to zero.

HOLD:
Switch depressed. The wavelength and filter drive motors are both stopped but without disturbing the control logic counting sequence.

RELEASE:
Switch released. Scan continues normally without any manual resetting of the initial wavelength required.

REMOTE: Latched pushbutton switch which interrupts the START/STOP switch and enables remote operation of the Wavelength Control Module through the lower panel connector (J2-Pin 15).

ON/OFF: Latched pushbutton switch which turns on AC power when depressed.

4. Model 555-67 Data Controller

The Model 555-67 Data Controller (Figure 9) connects to the Model 555-66 Wavelength Control Module to facilitate automatic data recording by controlling the wavelength increment at which data is taken, the data transfer rate, and the readout setting time. Variable data transfer times permit the Model 555 Spectroradiometer System to be conveniently interfaced with various recorders, printers, and computers.

Model 555-67 Characteristics

λ STEPPING INCREMENT: Two digit thumbwheel switch that is used to select the wavelength increment from 1 nm to 99 nm at which data points will be recorded.

READOUT SETTLING TIME: Controls the time period (0-30 seconds) during which the Model 550-1 Radiometer/Photometer monitors the signal current. The small indicator lamp to the left of the READOUT SETTLING TIME switch is lighted while the signal current is being monitored by the Model 550-1.

DATA TRANSFER SWITCH: Controls the time period (0-5 seconds) for transfer of BCD coded data from the Model 550-1 Indicator Unit to the data recording equipment. The small indicator lamp to the left of the switch is lighted during the data transfer time. Systems such as a Hewlett-Packard calculator require only a millisecond for data transfer and, thus, the control may be set near zero. Systems such as data converters which go into remote teletypes may require 1-2 seconds for data transfer.

5. Automatic Data Recording

The Model 550/555 Spectroradiometer can be conveniently coupled to a Hewlett-Packard Model 9815 Desk Top Calculator to produce an effective and automatic measurement/computer/printout system. Software programs (Model 555-20) are available from EG&G for the 555/HP9815 System combination. The tabulation shown in Figure 10 is an actual real-time printout of absolute spectral irradiance for a broadband source using the 550/555/HP 9815 combination. In this example, as the system scans through the visible spectrum (380-760 nm) in 10-nm increments, the signal current in amperes is measured and instantly converted to values of irradiance using the spectroradiometer calibration data which is stored on tape in the calculator. At the end of the scan, the program uses the spectral data to immediately calculate accurate values of photometric output, integrated radiometric output, chromaticity coordinates, and correlated color temperature of the source. Total time for the automatic scanning, data acquisition at 10 nm intervals, and data interpretation to arrive at the final values shown in this example is approximately

2 to 3 minutes.

The H-P Model 9815 Calculator is only used as an example. Any other calculator, teletype, tape, computer, or recording system that will accept BCD information can be used. (See EG&G Application Note L2023A-1, Computer Interfacing for Spectroradiometer Measurements). The use of a calculator with a magnetic tape unit or a large memory facilitates automatic data measurements which can be made in increments as small as 1 nm. Summations can then be easily performed over any desired spectral region, and curve multiplications can be readily accomplished. This technique lends itself to many applications including very accurate U-V hazards, photometric and colorimetric measurements.

MODEL 555 SPECTRORADIOMETER OPERATION

The following instructions explain the step-by step procedures that should be followed to obtain satisfactory measurement results with the Model 555 Spectroradiometer System.

1. Basic Operating Setup
   1) Push ON/OFF button to power up Model 550-1 Radiometer/Photometer (allow a 15 minute warmup period for maximum stability in most sensitive range).
   2) Connect the Model 550-2 Multiprobe to the rear of the Model 555-61 Monochromator Assembly.
   3) Turn Model 550-2 Multiprobe switch to position 1 (nanoamps) and set Unit Selector on Model 550-1 to nanoamps.
   4) Connect Model 550-2 Multiprobe to Model 550-1 Radiometer/Photometer using cable supplied.
   5) Select the desired slit widths to be used in the measurements and install them in the 555-61 Monochromator Housing.
   6) Align the system to the source being measured. The source being measured must be set up within a ±5° cone as measured from the diffuser. The plane of the diffuser is always the system reference point for all calibrations.

2. Procedure for Measuring Spectral Irradiance of a Steady Source.
   Manual Mode
   1) Align the Spectroradiometer as previously described.
   2) Set the monochromator to the desired wavelength.
   3) Rotate proper order sorting filter into position.
   4) Energize the source to be measured.
   5) Push AUTORANGE button (or manually range to desired level).

6) Block light source and adjust ambient zero control to null the readings due to unwanted ambient light. Compensation is increased by rotating the thumbwheel to the left.
(CAUTION): (This is a 50 turn control which can be damaged if if carelessly forced beyond mechanical limits).
7) Unblock light source.
8) Record the final meter reading. The final current in nanoamps is proportional to the irradiance incident on the system.
9) Repeat measurement procedure at desired wavelengths.

TYPICAL EXAMPLE

What is average power of a light source whose output at 700 nm gives a meter reading of 4×10^{-7} amperes? The system sensitivity at 700 nm is 0.02 A/W/cm^2 nm with 10 nm slits.

$$H_{700} = \frac{I_{700}}{S_{700}} = \frac{4 \times 10^{-7} \text{ amp}}{.02 \text{ A/W/cm}^2 \text{ nm}}$$

$$H_{700} = 2 \times 10^{-5} \text{ W/cm}^2 \text{ nm}$$

3. Measurement Procedure for Measuring Integrated Spectral Irradiance of a Pulsed Source - Manual Mode

1) Follow the basic operating setup on page 14 but set the Unit Selector on the Model 550-1 to nanocoulombs.
2) Connect the 550-2 Multiprobe cable to the Pulse Integration Module (PIM). Connect cable on rear of PIM to the 550-1 Radiometer/ Photometer Indicator Unit.
3) Set the monochromator to the desired wavelength and rotate proper order sorting filter into position.
4) Select range sensitivity of PIM.

5) Move function switch from RESET to INTEGRATE and adjust AMBIENT ZERO control until there is no upward or downward meter movement.

6) To make a measurement, set function switch to RESET, move to INTEGRATE and energize light source, and then move to HOLD to lock the reading.

TYPICAL EXAMPLE

What is the integrated spectral irradiance of a pulsed source of 1.06μ whose output gives a meter reading of $1x10^{-9}$ coulombs? The system sensitivity at 1.06μ is 0.1 coulombs/joule/cm^2-nm

Q = charge measured on meter in coulombs

S_λ = system sensitivity at wavelength λ in coulombs/joule/cm^2-nm

$$E_{1060} = \frac{1x10^{-9}}{0.1} = 1x10^{-8} \text{ joule/cm}^2\text{-nm}$$

4. Measurement Procedure - Automatic Mode

1) Align the Spectroradiometer as previously described.

2) Select the wavelength reading increment to be used. Set the λ STEPPING INCREMENT switches on the Model 555-67 Data Controller to this number.

Note: Stepping increment of 01-99 nm may be selected.

3) Turn the Monochromator wavelength counter dial to the starting wavelength minus one increment. For example, if 350 nm is the first wavelength at which data is to be taken, and the wavelength increment is 10 nm, set the wavelength counter to 340 nm (350-10 = 340).

4) Manually rotate proper order sorting filter into position.

5) Set order sorting filter sequencing wavelengths into the FILTER λ INCREMENTS (NM) switches. For example, if the starting wavelength minus one increment is 340 nm, and the first order sorting filter change occurs at 350 nm, set 10 (350-340 = 10 nm) into the first set of thumbwheel switches. The next order sorting filter change occurs at 400 nm. Therefore, set 60 (400-340 = 60 nm) into the second set of thumbwheel switches. The next order sorting filter change occurs at 600 nm. Therefore, set 260 (600-340 = 260 nm) into the third set of switches.
6) Set λ SCAN INTERVAL (NM) switch to coincide with desired length scan. For example if data is to be taken from 350 to 800 nm in 10 nm increments subtract the first wavelength minus one increment from the final wavelength. In this example 800-340 = 460 nm. Therefore, set 460 into the thumbwheel switches.
7) Select desired scan speed from the λ DRIVE SPEED (NM/MIN) switches.
8) Select desired scan mode from the λ DRIVE CONTROL switches.
9) Set READOUT SETTLING TIME control to coincide with the slowest range on the Model 550-1 Radiometer/Photometer that will be used. The 10^{-3} range typically requires a 6-10 second settling time. A 1-second settling time should be adequate for the remaining ranges.
10) Set DATA TRANSFER TIME control to the amount of time needed to transfer data from 550-1 Indicator into the device being used to record the data. If this time is set too short, no data will be transferred. If set too long, more than one data point will be recorded which can cause error in data conversion from software.
11) Depress the Model 555-65 POWER switch.
12) Depress the Model 555-65 START/STOP button. The wavelength counter dial should start moving immediately and stop at the first data wavelength. The amount of time it is stopped at all data wave-

length is the data settling time plus the data transfer time. This cycle is then repeated until the last wavelength is reached.

5. Automatic Spectroradiometer Scan Setup

TYPICAL EXAMPLE

The spectrum of a tungsten lamp is to be measured from 310 to 800 nm in 10 nm increments. A typical data page setup for this is shown in Figure 11. A chart to determine approximate total scan time is shown in Figure 12.

OPERATING INSTRUCTION FOR MODEL 555-30 SERIES OF PMT DETECTOR HEADS

1. General

Operation of a Model 550/555 Spectroradiometer System using a Model 555-30 Series PMT Detector Head is generally similar to operation using the Model 550-2 Silicon Detector Head described previously. The only real difference is that with the PMT, care must be taken to operate the detector at the proper voltage to maintain system calibration. Also, care should be exercised to prevent detector saturation and even possible detector damage. The operating procedure described below, although directed at operation of the detector for use as a spectroradiometer, also applies for use as a radiometer system.

CAUTION

The Model 555-30 Series of PMT Detector Heads are much more susceptible to damage due to excessive incident radiation than the 550-2 Silicon Detectors, especially when the power supply to the PMT is turned-on. Therefore, the following precautions should be observed.

1. When using the PMT Detector as a Radiometer for broadband radiation measurements, the level of light the Detector is subjected to should not be high enough to saturate the photomultiplier. Therefore, before the shutter is opened, the ambient level should be decreased to a value somewhere near the source to be measured. The safe level of operation of the PMT Detector as a Radiometer can be determined by setting the Range on the 550-1 Indicator Unit manually to +2. The shutter of the PMT Detector should then be opened slowly. If the level of light is such that the meter overranges on the + 2 range as indi-

cated by a blinking on the digital meter, then the level of incident radiation is too high and the shutter should be closed immediately.

2. When the Spectroradiometer configuration is used, the problem described above is not as critical since there is only one wavelength of light available to the photomultiplier. However, care should still be exercised not to expose the PMT for an extended period of time to a level of radiation that will cause the 550-1 to indicate readings above the +2 range. Note also that when measurements are made with a Spectroradiometer, the amount of ambient light will change with the wavelength. If there is a reading of ambient light on the scale where the source is measured, then the ambient must be balanced at each wavelength. If the reading is only the leakage of the photomultiplier, this value can be balanced out at any wavelength and checked occasionally. When the ambient light and photomultiplier leakage are balanced out, the source is measured in the conventional manner with the shutter open.

2. Basic Operating Setup

   1) Remove protective black aperture cap from PMT Detector Head.
   2) Couple PMT Detector to the exit aperture of the Model 555-61 Monochromator using the threaded slip ring connector on the PMT Detector Head housing.
   3) Connect the Indicator Signal Input coaxial cable from the BNC connector on the rear of the PMT Detector to the 550-1 Indicator Unit. The 14 pin connector on the rear of the 550-1 Indicator is converted to accept the coaxial cable with BNC connector from the PMT Detector by means of the 550-12 Input Adapter that is supplied as part of the 550-30 Series of PMT Detector Head Systems.
   4) Connect the Model 555-30 Power Supply to the PMT Detector Head by means of the cable with the 5 pin AMP connectors on each end.

5. Set the unit indicator on Model 550-1 to read nanoamperes.
6. Set AUTO/MANUAL switch on 550-1 to MANUAL and set range to +1.
7. Set Model 555-30 Power Supply POWER switch to ON.
8. Set Model 555-30 Power Supply CAL. LAMP switch to ON. Be sure that shutter on Detector Head is closed.
9. Adjust voltage control knob on front panel of 555-30 Power Supply until a reading of 100.0 is obtained on the digital display of the 550-1 Indicator. This should now correspond to a reading of $100.0 \times 10^{+1}$ nanoamperes or 1.0 micro-amp.
10. Set CAL. LAMP switch on Model 555-30 to OFF.
11. Range down to -2 range on 550-1 Indicator to measure the dark current of the PMT. Use ambient compensation control on front panel of Model 550-1 to zero out the dark current.
12. Set AUTO/MANUAL range switch on 550-1 to AUTO.
13. Repeat steps 8-11 to assure that PMT is at proper operating voltage for system calibration to be valid.
14. With source to be measured turned off, slowly open shutter of PMT Detector. Be sure that ambient light does not cause 550-1 to go above +2 range.
15. Use ambient compensation control on 550-1 Indicator to compensate out the combination of PMT dark current and ambient light. If this is not possible, then the level of ambient light must be reduced.
16. Close shutter of PMT Detector.
17. Turn on source to be measured.
18. Slowly open shutter of PMT Detector. Be sure that light level does not cause 550-1 to go above +2 range for an extended period of time.

19. Proceed with measurements as described previously for spectroradiometer system with Silicon Detector.

NOTE: 1. A reading above the +2 range on the 550-1 Indicator, while not necessarily indicative of possible damage to the PMT, would indicate that the level of radiation is such that the response from the PMT could be non-linear and, therefore, erroneous data could be obtained.

2. A warm up time of 30 minutes should be allowed for PMT stabilization.

CAUTION

Be sure to close shutter at conclusion of measurements, and before PMT Detector is removed from the monochromator.

3. Model 555-30 PMT Power Supply

The Model 555-30 Power Supply connects to the PMT Detector Head by means of a cable with 5 pin AMP connectors on each end as described in Step 4 of the previous section on Basic Operating Setup. On the front panel of the 555-30 there is the main power ON/OFF switch, an ON/OFF switch which operates the internal calibration lamp in the PMT Detector Head, and a variable control which sets the proper PMT operating voltage in conjunction with the calibration lamp as described in Steps 7-13 of the previous section.

The front panel reference lamp switch is internally paralleled by a normally-open reed relay which is connected to the rear panel BNC labeled REMOTE REFERENCE LAMP, 5 VDC. Application of +5VDC (which is TTL compatible and accessible from any calculating/computing system) to the rear panel BNC activates the relay and turns on the reference lamp. This enables convenient remote checking of the PMT calibration level/operating voltage. When this procedure is followed, the signal being displayed on the 550-1 Indicator with the calibration lamp turned off should be at least three decades below the normal calibration lamp reading of $100.0 \times 10^{+1}$ nanoamperes so that the external ambient lighting will not affect the calibration lamp measurement.

INSTRUCTIONS FOR ANALOG OR CHART RECORDINGS

1. Connect cable from BNC-plug on rear panel of Model 550-1 Indicator Unit to the Y-axis of chart recorder.
2. Connect a cable from the BNC connector marked RECORDER which is located on the side of the monochromator assembly to the X-axis of a chart recorder.
3. Supply + 5 volts DC to the BNC connector marked ±V on the side of the monochromator assembly.

   Note: a) This is a ten turn potentiometer which is geared to one turn per 100 nm and restricts the range of the wavelength control to approximately 175 to 1175 nm. Forcing the wavelength control beyond this region can cause damage to the monochromator system.

   b) If the Model 555-66 Wavelength Control Module is available, the BNC-plug on the rear panel contains + 5VDC which may be used to drive the wavelength potentiometer. The power switch must be in the "on" position to energize the + 5 volts.
4. Scans may be made by manually turning the wavelength control knob or automatically by programming the Model 555-66 Wavelength Control Module. In this mode of operation, the Model 555-67 Data Controller is not needed and should be disconnected from the Model 555-66 Wavelength Control Module.
5. The 550-1 Indicator Unit only outputs the 3-1/2 digit panel meter reading with a maximum reading of 1.999 volts. No information on the proper decade of response is available on analog output. Therefore, in this mode of operation, it is advisable to keep the 550-1 in the MANUAL mode so that it will not autorange to a different decade.

Instructions for Fiber Optic Probe

1. Remove diffuser from 555-62 Filter Wheel Assembly by loosening the set screw located under the diffuser near the bottom of the cylinder approximately 1-inch in from the front of the assembly and sliding the diffuser out of the barrel. Caution: Avoid contaminating diffuser with dirt or finger prints.

2. If 550-14-1 Fiber Optics Probe is used with special adapter that connects directly to 550-2 Detector, then loosen set screw on adapter and remove adapter from fiber probe.

3. Install new adapter for 555-61 Monochromator and tighten set screw. Fiber probe will extend beyond adapter by approximately 1/16-inch.

4. Insert fiber probe with small adapter for spectroradiometer into 555-62 Filter Wheel Assembly as far as possible and then re-tighten set screw on bottom of assembly that previsouly held the diffuser in place.

5. Proceed with measurements.

MODEL 555 SPECTRORADIOMETER CALIBRATION

The calibration data for the Model 555 Spectroradiometer is presented in a tabular form as shown in Figure 13. The calibration certificate contains the model and serial numbers of all the units used in the calibration. The calibration was performed as described below.

1.) The reference surface, the plane of the diffusers, is set at a specified distance, typically 100 cm, from a 1000 watt standard lamp whose calibration is directly traceable to the National Bureau of Standards.

2.) A set of current readings is taken at specific intervals over the region being calibrated.

3.) The ratio of detector current to the irradiance incident on the system at each wavelength is the absolute spectral sensitivity in amp/(watt/cm^2-nm) of the system under calibration.

A typical sensitivity curve of the Model 555 Spectroradiometer is shown in Figure 14.

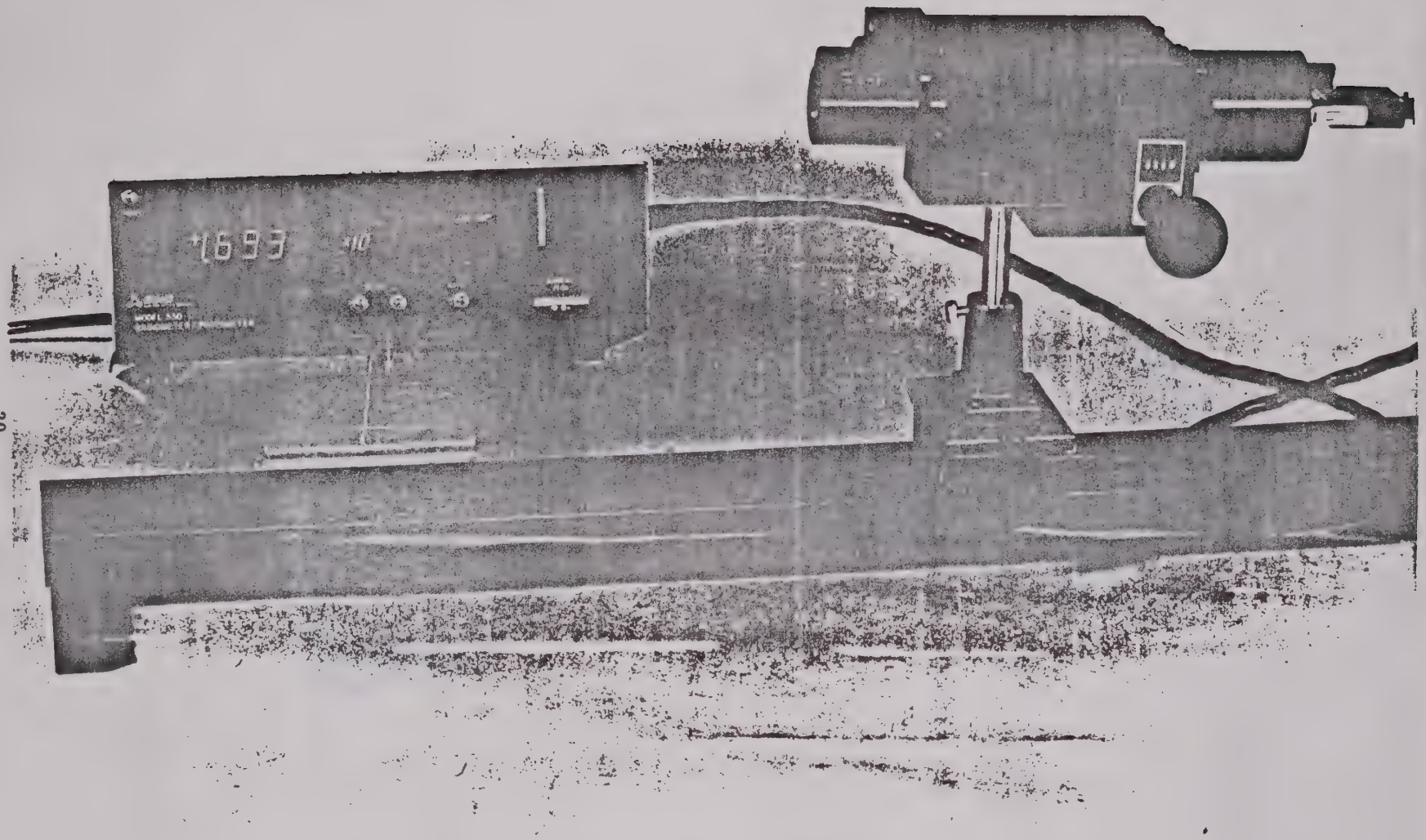


FIGURE 1 - BASIC MODEL 555 SPECTRORADIOMETER

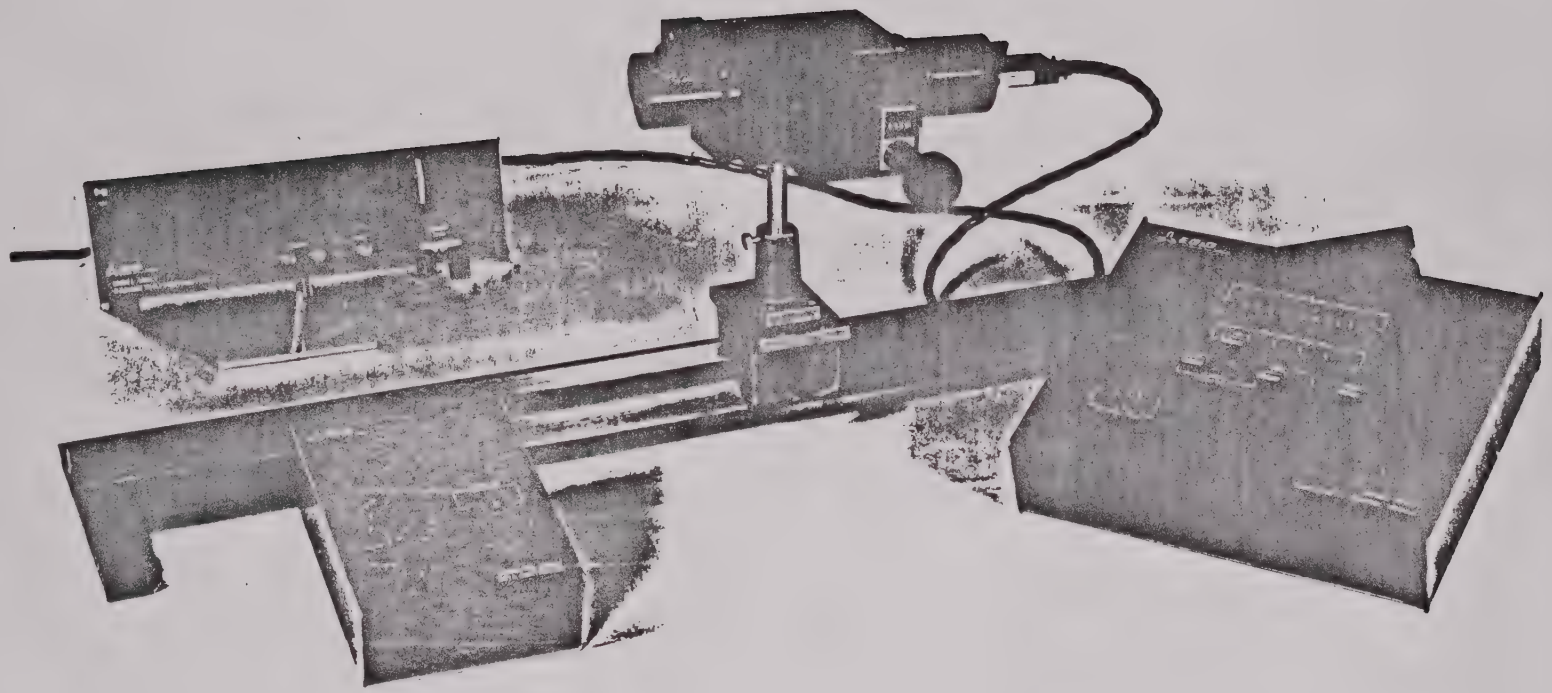
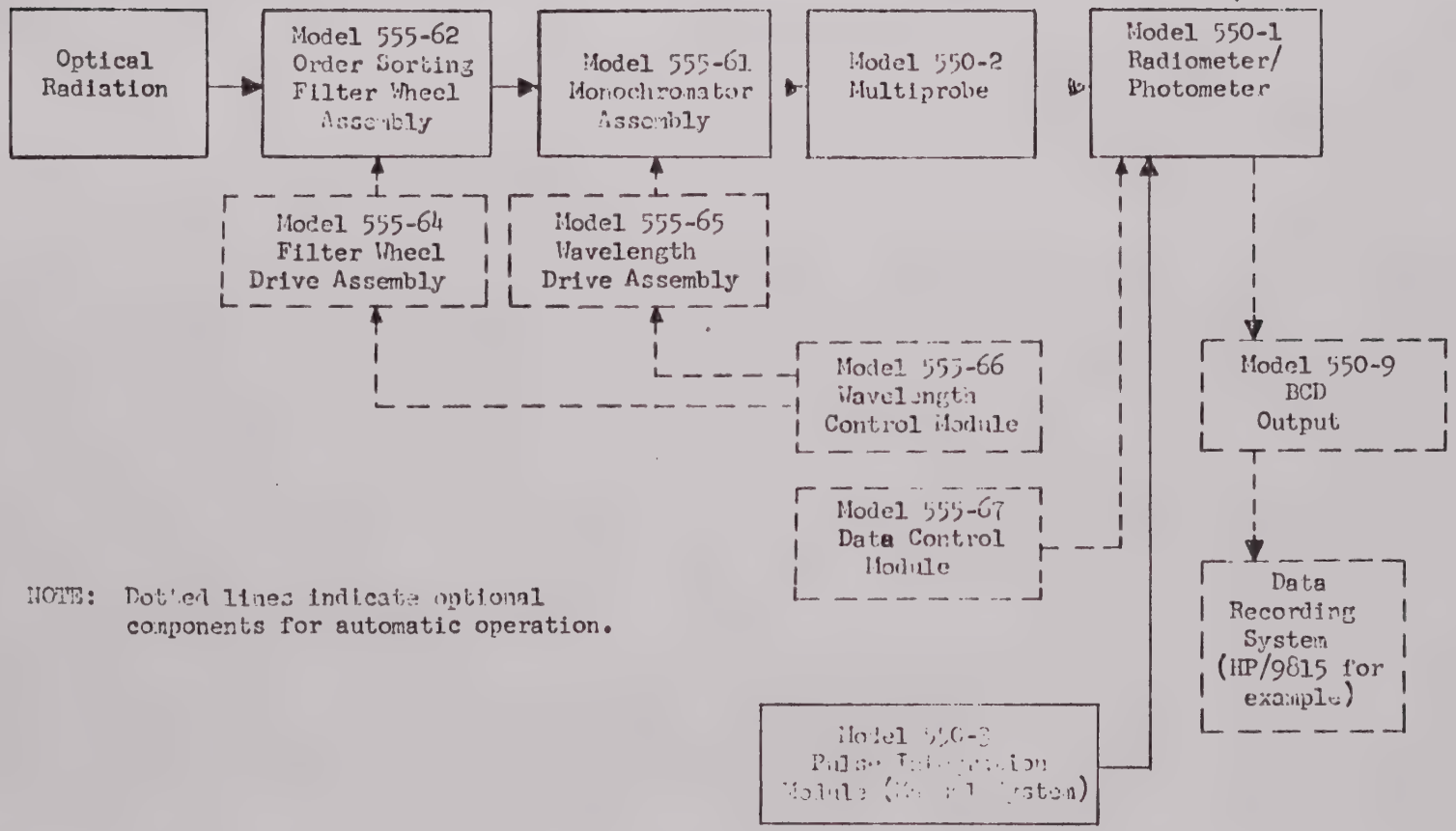


FIGURE 2 - AUTOMATIC MODEL 555 SPECTRORADIOMETER

FIGURE 3

FUNCTIONAL BLOCK DIAGRAM OF MODE 555 SPECTRORADIOMETER SYSTEM


Optical Radiation
Model 555-62 Order Sorting Filter Wheel Assembly
Model 555-61 Monochromator Assembly
Model 550-2 Multiprobe
Model 550-1 Radiometer/ Photometer
Model 555-64 Filter Wheel Drive Assembly
Model 555-65 Wavelength Drive Assembly
Model 555-66 Wavelength Control Module
Model 555-67 Data Control Module
Model 550-9 BCD Output
Data Recording System (HP/9815 for example)
Model 550-3 Pulse Integration Module

NOTE: Dotted lines indicate optional components for automatic operation.

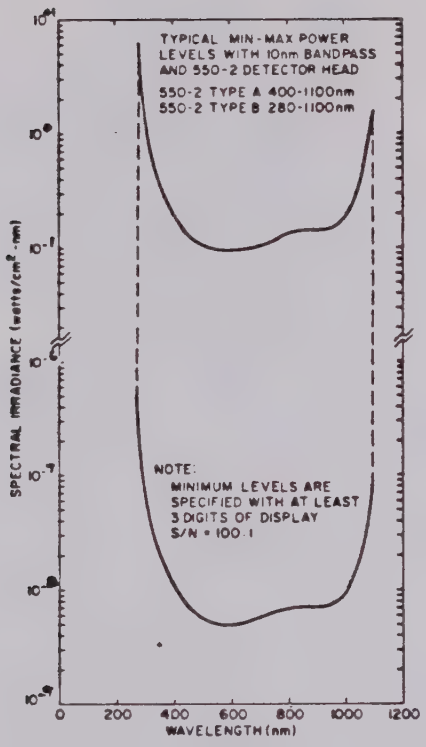


FIGURE 4

MINIMUM/MAXIMUM SPECTRAL IRRADIANCE LEVELS

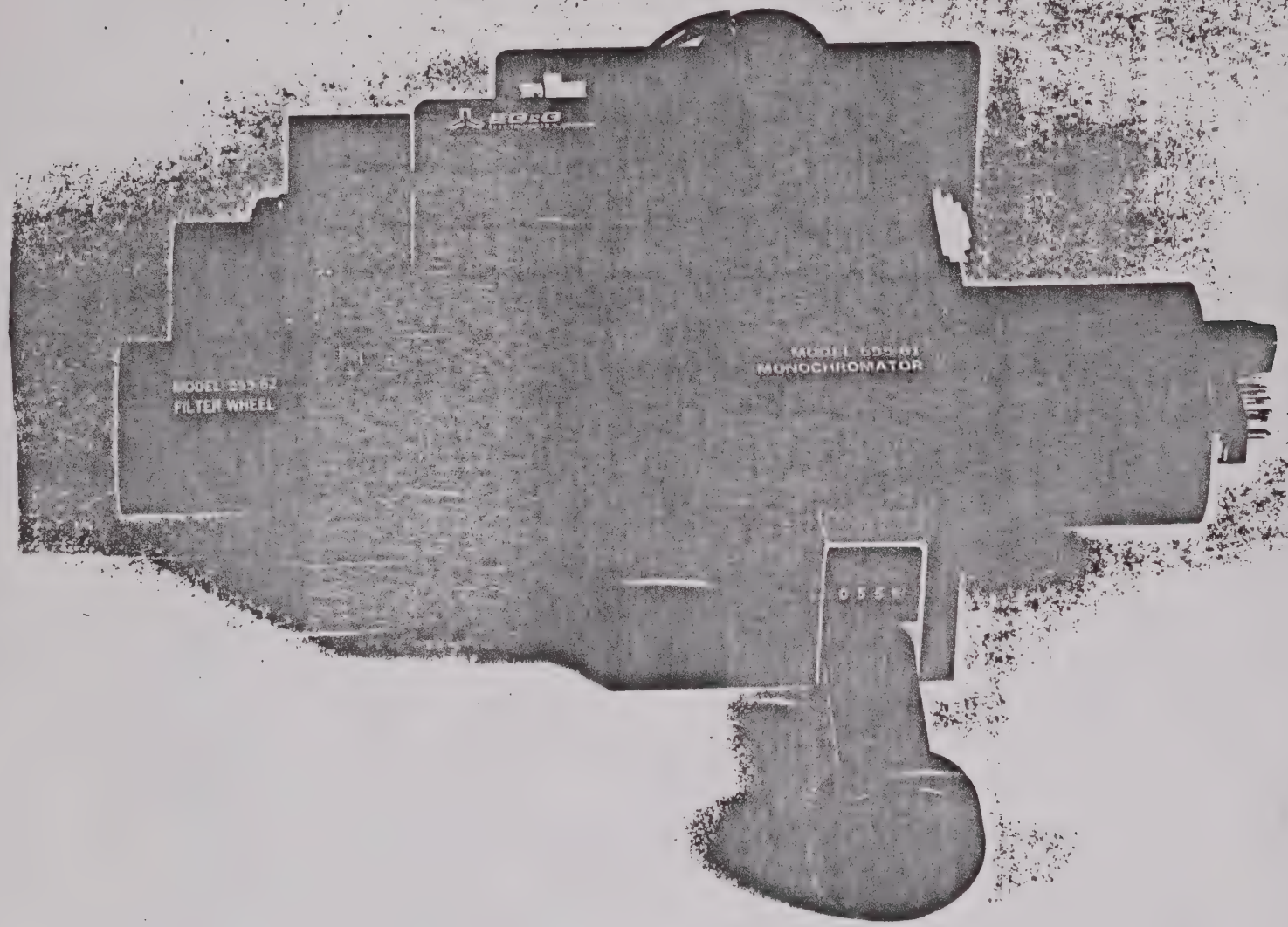


FIGURE 5 - MODEL 555-61 MONOCHROMATOR

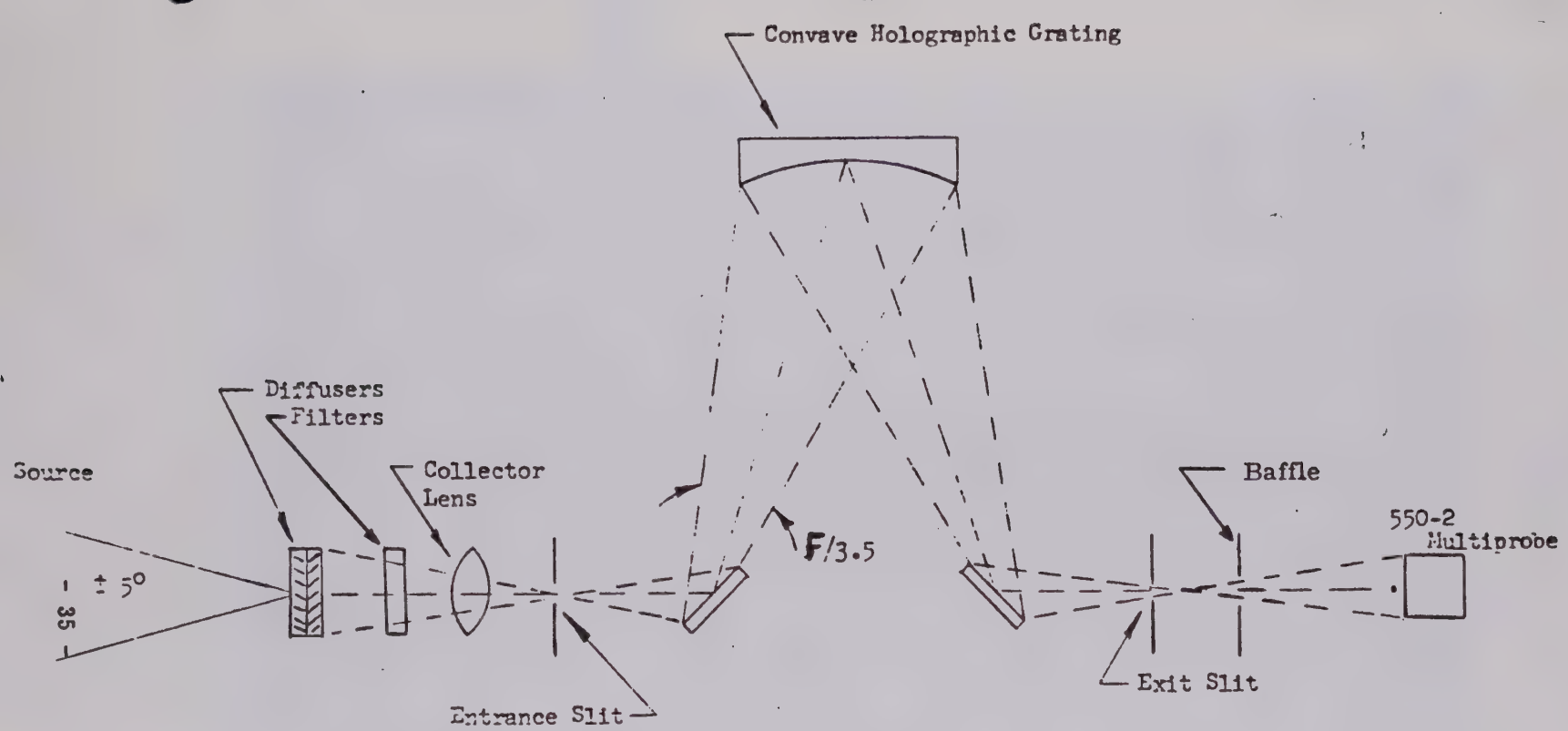


FIGURE 6

MODEL 555 SPECTRORADIOMETER SCHEMATIC

The Model 550/555 Spectroradiometer provides digital and analog output of both intensity and wavelength with either the manual or automatic scanning system. BCD output is optional (Model 550-9), and is necessary for automatic data recording systems. The spectrum scans of a low pressure mercury lamp shown below are typical examples of the Model 550/555 Spectroradiometer System operated as an analog scanning device. They also illustrate the importance of using proper harmonic order-sorting filters (Model 555-62) in a single beam monochromator system. It can be seen from the second scan that the lack of order-sorting filters would result in spurious irradiance spikes due to second order effects of the diffraction grating.

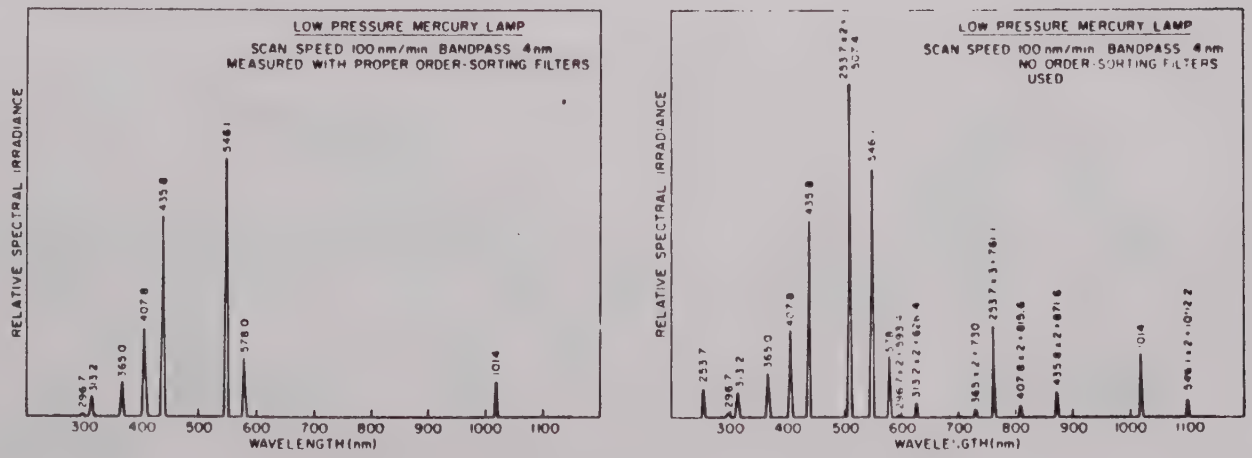


FIGURE 7 - SPECTRUM SCANS OF LOW PRESSURE MERCURY

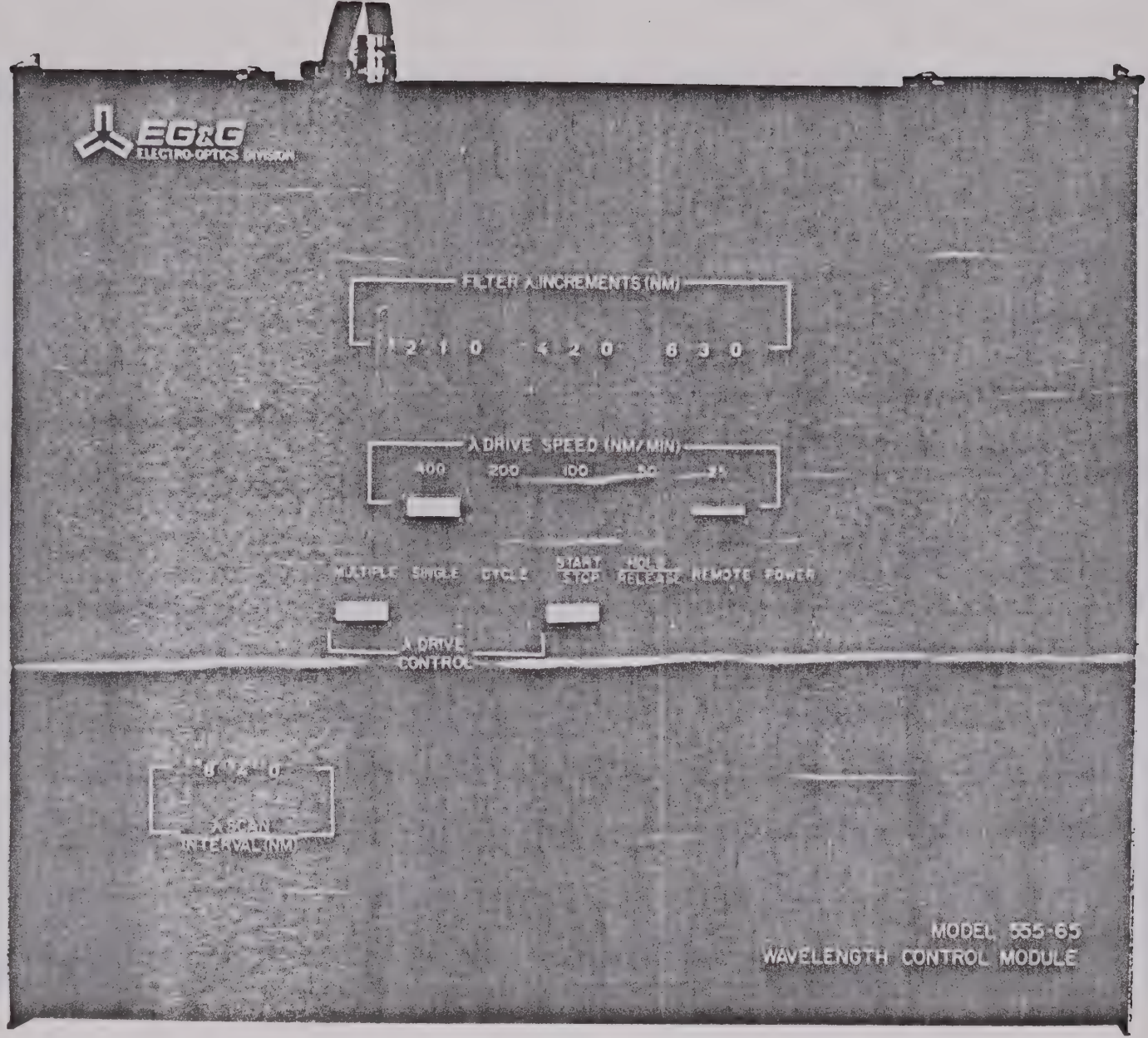


FIGURE 8 - MODEL 555-66 WAVELENGTH CONTROL MODULE

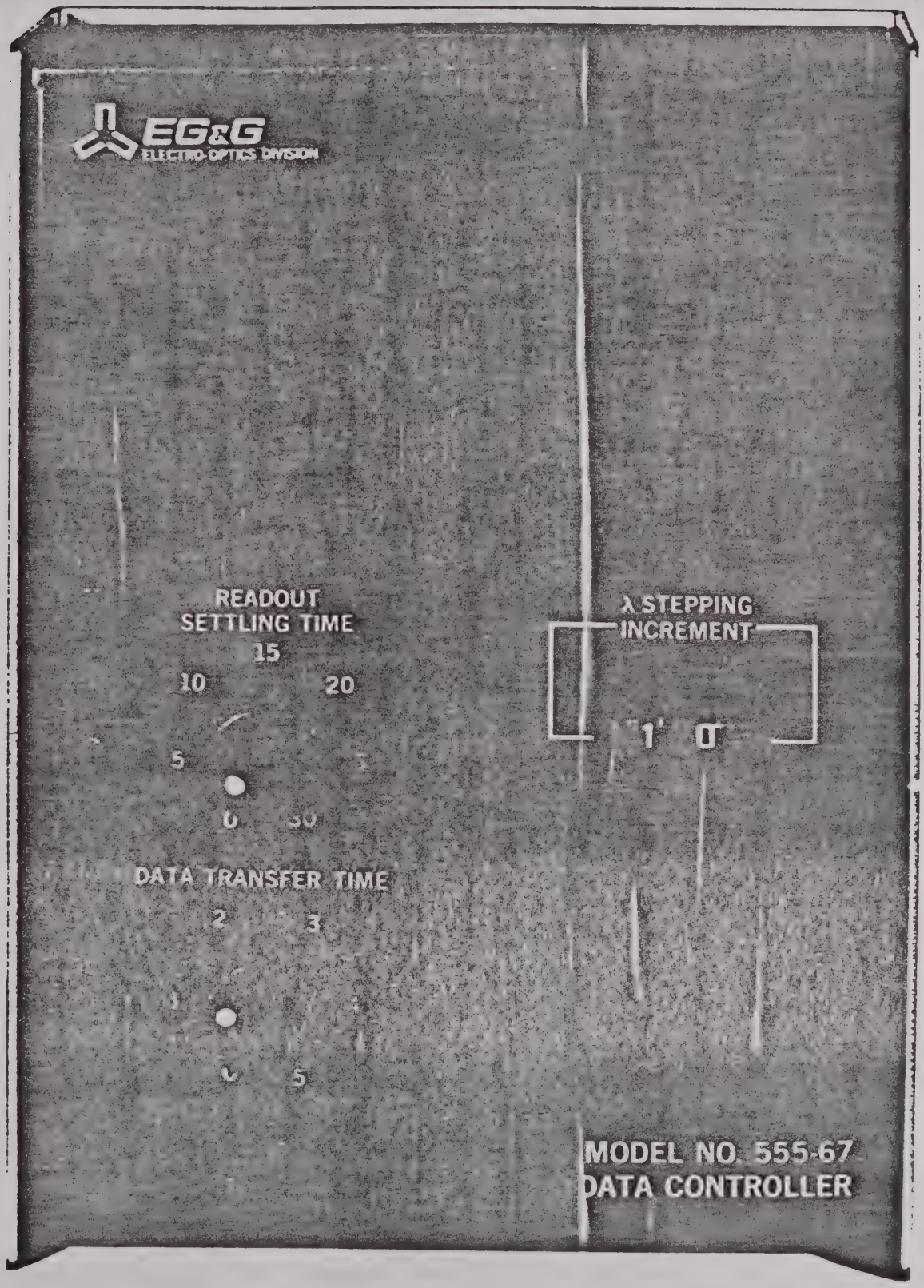


FIGURE 9 - MODEL 555-67 DATA CONTROLLER

```
                380NM
2.92 -09W/CM↑2NM
2.89 -09W/CM↑2NM
4.02 -09W/CM↑2NM
[illegible]
[illegible]
                [illegible]
[illegible]
6.14 -08W/CM↑2NM
7.22 -08W/CM↑2NM
8.56 -08W/CM↑2NM
9.83 -08W/CM↑2NM
                480NM
1.10 -07W/CM↑2NM
1.23 -07W/CM↑2NM
1.38 -07W/CM↑2NM
1.54 -07W/CM↑2NM
1.70 -07W/CM↑2NM
                530NM
1.88 -07W/CM↑2NM
2.07 -07W/CM↑2NM
2.24 -07W/CM↑2NM
[illegible]
[illegible]
                [illegible]
2.84 -07W/CM↑2NM
3.01 -07W/CM↑2NM
3.15 -07W/CM↑2NM
3.37 -07W/CM↑2NM
3.56 -07W/CM↑2NM
                630NM
3.73 -07W/CM↑2NM
3.90 -07W/CM↑2NM
4.10 -07W/CM↑2NM
4.26 -07W/CM↑2NM
4.39 -07W/CM↑2NM
                680NM
4.55 -07W/CM↑2NM
4.70 -07W/CM↑2NM
4.84 -07W/CM↑2NM
4.95 -07W/CM↑2NM
5.09 -07W/CM↑2NM
                730NM
5.20 -07W/CM↑2NM
5.28 -07W/CM↑2NM
5.48 -07W/CM↑2NM
5.56 -07W/CM↑2NM

LM/CM↑2=1.78 -02
LM/FT↑2=1.56  05
LM/M↑2= 1.78  02
X=          0.4534
Y=          0.4125
U=          0.2575
V=          0.3514
CCT    2809KELVIN
SUM 380-760 NM=
  1  05 -04W/CM↑2
```

FIGURE 10 - TABULATION OF AUTOMATIC DATA PRINTOUT

FIGURE 11

TYPICAL SET-UP FOR AUTOMATIC SCANNING

1.	Source to be measured: Tungsten Lamp	
2.	Spectral Scan from 310nm to 800nm	
3.	Wavelength Increment	10nm (set in λ stepping increment, Model 555-67)
4.	Ending Wavelength	800nm
5.	Starting Wavelength minus one increment	300nm (set into wavelength counter, Model 555-61)
6.	Range (line 4 - line 5)	500nm (set into λ Scan Interval, Model 555-66)
7.	First Filter Change (350nm - line 5)	50nm (set into first Filter λ increment switch, if not negative)
8.	Second Filter Change (400nm - line 5)	100nm (set into second Filter λ Increment switch, if not negative)
9.	Third Filter Change (600nm - line 5)	300nm (set into third Filter λ Increment switch, if not negative)

Set-up to scan from _____ nm to _____ nm in _____ nm increments

1) increment = _____ nm
2) ending λ = _____ nm
3) starting λ-1 inc = _____ nm (set into counter)
4) Range (line 3 - line 2) = _____ nm (set into pot 4)
5) 350 - start λ-1 inc = _____ nm (set into pot 4 if not minus)
6) 400 - start λ-1 inc = _____ nm (set into pot 2 if not minus)
7) 600 - start λ-1 inc = _____ nm (set into pot 3 if not minus)

CALCULATING RUNNING TIMES

8) Range ÷ scan speed = _____ ÷ _____ nm/min = _____ min
9) No. of filter changes x .0228 min = _____ x .0028 min = _____ min
10) No. of data points = Range ÷ inc = _____ ÷ _____ = _____
11) Data settling time x NDP = _____ min x _____ = _____ min
12) Data transfer time x NDP = _____ min x _____ = _____ min
13) Total can time = sum of 8, 9, 11, & 12 = _____ min
14) Time to return to start λ = 8+9 = _____ min
15) Total cycle time = 13+14 = _____ min

FIGURE 12 - CHART FOR APPROXIMATE SCAN DURATION

550/555 SPECTRORADIOMETER CALIBRATION

MODEL NO.	DESCRIPTION	S/N
550-2B	DETECTOR HEAD	B732
555-61	MONOCHROMATOR	108
	MONOCHROMATOR SLITS	10 NM
555-62	FILTER WHEEL	108
	ORDER SORTING FILTERS	

CODE	WAVELENGTH
.	280-350NM
..	350-400NM
...	400-600NM
....	600-1100NM

TRACEABILITY TO NBS-STANDARD LAMP NO. A290A

CERTIFICATE NO. 550-2B-B732-1

DATE 09/24/77

CALIBRATED BY D. MOODY

EG&G CERTIFIES THAT THE ABOVE CALIBRATION WAS PERFORMED USING STANDARDS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS

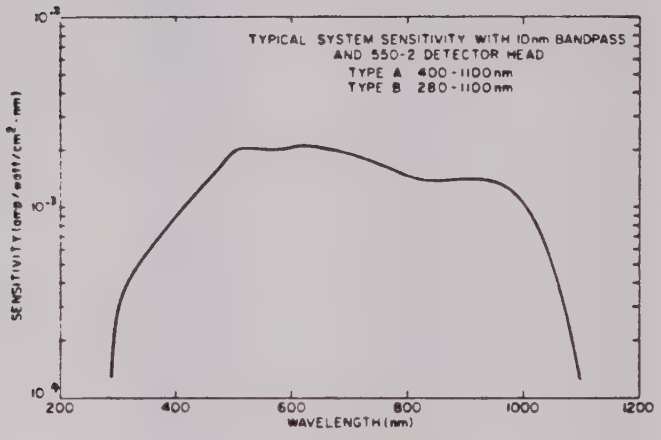
FIGURE 13 - TYPICAL SYSTEM CALIBRATION DATA

WAVELENGTH NANOMETERS	SENSITIVITY AMP/WATT/SQ-CM-NM
280	.345E-4
290	.702E-4
300	.117E-3
310	.15 E-3
320	.179E-3
330	.202E-3
340	.229E-3
350	.239E-3
350	.253E-3
360	.29 E-3
370	.315E-3
380	.31 E-3
390	.21 E-3
400	.829E-4

TEST NO. 1732
PAGE
EG&G INC

WAVELENGTH NANOMETERS	SENSITIVITY AMP/WATT/SQ-CM-NM
400	.747E-3
410	.883E-3
420	.104E-2
430	.106E-2
440	.105E-2
450	.102E-2
460	.105E-2
470	.119E-2
480	.141E-2
490	.16 E-2
500	.176E-2
510	.189E-2
520	.199E-2
530	.196E-2
540	.189E-2
550	.21 E-2
560	.219E-2
570	.216E-2
580	.207E-2
590	.193E-2
600	.175E-2
600	.255E-2
610	.268E-2
620	.274E-2
630	.278E-2
640	.28 E-2
650	.283E-2
660	.283E-2
670	.284E-2
680	.282E-2
690	.281E-2
700	.28 E-2
710	.28 E-2
720	.278E-2
730	.281E-2
740	.297E-2

WAVELENGTH NANOMETERS	SENSITIVITY AMP/WATT/SQ-CM-NM
750	.282E-2
760	.263E-2
770	.255E-2
780	.249E-2
790	.245E-2
800	.242E-2
810	.24 E-2
820	.239E-2
830	.239E-2
840	.241E-2
850	.244E-2
860	.251E-2
870	.255E-2
880	.263E-2
890	.269E-2
900	.275E-2
910	.282E-2
920	.289E-2
930	.294E-2
940	.297E-2
950	.301E-2
960	.302E-2
970	.302E-2
980	.299E-2
990	.292E-2
1000	.281E-2
1010	.264E-2
1020	.241E-2
1030	.213E-2
1040	.18 E-2
1050	.145E-2
1060	.111E-2
1070	.873E-3
1080	.704E-3
1090	.553E-3
1100	.427E-3



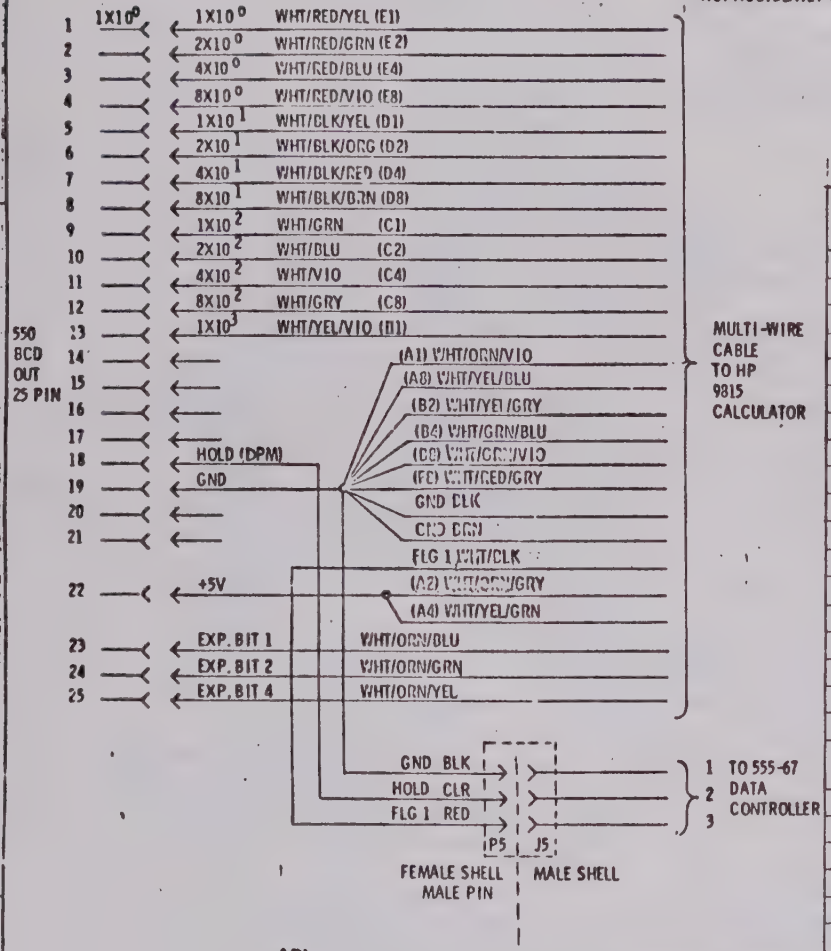
Model 550/555 Spectroradiometers are individually calibrated on a complete system basis using standards traceable to the National Bureau of Standards. Thus the transmission characteristics of the Monochromator and the Detector sensitivity are incorporated into a single system sensitivity curve. Tabulated calibration data of sensitivity versus wavelength are provided in computer printout for each system.

FIGURE 14 - TYPICAL SYSTEM SENSITIVITY

NOTES:

1. ALL UNDESIGNATED WIRES TO THE 9815 ARE LEFT UNCONNECTED. CUT AND TAPE SO THAT THEY DO NOT ACCIDENTLY SHORT TO ANY OTHER POINT.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	HOLD (DPM) WAS CONNECTED TO P5 (RED), FLG 1 WHT/BLK WAS CONNECTED TO P5 CLR, ADDED MALE & FEMALE DESIGNATIONS TO P5 & J5, PER DCN CIB	1/24/79	S.W.



WIRING INFORMATION FOR 550/555 AND H.P. 9815 CALCULATOR

EG&G PIN NO.	EG&G FUNCTION	H.P. WIRE COLOR CODE	H.P. DESIGNATION
1.	$1X10^0$ DIGIT	WHT/RED/YEL	E1
2.	$2X10^0$ DIGIT	WHT/RED/GRN	E2
3.	$4X10^0$ DIGIT	WHT/RED/BLU	E4
4.	$8X10^0$ DIGIT	WHT/RED/VIO	E8
5.	$1X10^1$ DIGIT	WHT/BLK/YEL	D1
6.	$2X10^1$ DIGIT	WHT/BLK/ORN	D2
7.	$4X10^1$ DIGIT	WHT/BLK/RED	D4
8.	$8X10^1$ DIGIT	WHT/BLK/BRN	D8
9.	$1X10^2$ DIGIT	WHT/GRN	C1
10.	$2X10^2$ DIGIT	WHT/BLU	C2
11.	$4X10^2$ DIGIT	WHT/VIO	C4
12.	$8X10^2$ DIGIT	WHT/GRY	C8
13.	$1X10^3$ DIGIT	WHT/YEL/VIO	B1
14.	D.P.1, 188.8	NOT USED	-
15.	D.P.2, 18.88	NOT USED	-
16	D.P.3, 1.888	NOT USED	-
17.	$\overline{\text{PRINT}}$	NOT USED	-
18.	HOLD	TO P5	-
19.	DIGITAL GND	SEE 1	A8, A1, B8, B4, B2 F8, GND(BLK & BRN)
20	$\overline{\text{OVERRANGE}}$	NOT USED	-
21	POLARITY	NOT USED	-
22.	+5V	SEE 2	A4, A2
23	EXP. BIT 1	WHT/ORN/BLU	F1
24.	EXP. BIT 2	WHT/ORN/GRN	F2
25.	EXP. BIT 4	WHT/ORN/YEL	F4

1. H.P. LINES TO DIGITAL GROUND
A8-WHT/YEL/BLU
A1-WHT/ORN/VIO
B8-WHT/GRN/VIO
B4-WHT/GRN/BLU
B2-WHT/YEL/GRY
F8-WHT/RED/GRY
GND-BLK
GND-BRN

2. H.P. LINES TO +5V
A4-WHT/YEL/GRN
A2-WHT/ORN/GRY

P5 WIRING

CONTACT	COLOR CODE	FUNCTION
1	BLACK	GND
2	CLEAR	HOLD(PIN 18)
3.	RED	FLG 1 (WHT/BLK)

APL

SL9-153 CROSS INDEX

DASH NO | NEXT ASSY | USED ON | APPLICATION

UNLESS OTHERWISE SPECIFIED REFER TO PROCESS STANDARDS 61001 AND 61002
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± ANGLES ±
3 PLACE DECIMAL ±
2 PLACE DECIMAL ±
UNLESS OTHERWISE SPECIFIED
RESISTANCE VALUES ARE
OHMS ± % WATT
CAPACITANCE VALUES ARE IN
FARADS ± % VOLTS
DIODES ARE TYPE
TRANSISTORS ARE TYPE
DO NOT SCALE PRINT

MATERIAL
FINISH SPECS

DRAWN J.C. McAfee 9-6-78
CHECKED DATE
DESIGNER DATE
ENGINEER DATE
PROJECT ENGINEER DATE
PROJECT APPROVAL R.A. Opn 9/6/78 DATE

EG&G

Figure 15

PRACTICAL WIRING DIAGRAM
550/555 TO HP 9815 CALCULATOR

SIZE	CODE IDENT NO	TYPE		REV
C	25506		312879	A

SCALE SHEET

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	C	REVISED & REDRAWN PER DCN C 508	09-78	[illegible]
	D	PIN NO. 18 WAS: NOT USED, DCN NO. D241	11-79	[illegible]
	E	REMOVE CONNECTION PIN 17 DCN NO. E22	1/24/81	[illegible]

NOTES:

1. WIRED IN "STANDARD FORMAT" (H. P. MANUAL)
2. SHIELD AND DRAIN OF HP CABLE MUST NOT BE CONNECTED TO ANYTHING.
3. EXPONENT MUST BE MULTIPLIED BY 1×10^{-7} IN ORDER TO MAKE DIRECT READING IN ABSOLUTE AMPERES.
4. ALL UNUSED H. P. WIRES MUST BE LEFT UNCONNECTED.

PIN NO.	FUNCTION	H.P. WIRE COLOR CODE
1	$1X10^0$	WHT/RED/ORG
2	$2X10^0$	WHT/RED/YEL
3	$4X10^0$	WHT/RED/GRN
4	$8X10^0$	WHT/RED/BLU
5	$1X10^1$	WHT/BRN/RED
6	$2X10^1$	WHT/BRN/ORG
7	$4X10^1$	WHT/BRN/YEL
8	$8X10^1$	WHT/BRN/GRN
9	$1X10^2$	WHT/BLK/GRN
10	$2X10^2$	WHT/BLK/BLU
11	$4X10^2$	WHT/BLK/VIO
12	$8X10^2$	WHT/BLK/GRY
13	$1X10^3$	WHT/BLK/BRN
14	D.P.1	NOT USED
15	D.P.2	NOT USED
16	D.P.3	NOT USED
17	PRINT	NOT USED
18	HOLD	
19	DIG GND	WHT (SEE TABLE #1)
20	OVERRANGE	NOT USED
21	POLARITY	WHT/BRN/BLU
22	+5V	WHT/BRN/VIO
23	EXP BIT 1	WHT/ORG/YEL
24	EXP BIT 2	WHT/ORG/GRN
25	EXP BIT 4	WHT/ORG/BLU
		DFLGA WHT/BRN/GRY

550 BCD OUT 25 PIN

MULTI-WIRE CABLE TO H.P. 9825 CALCULATOR

TABLE #1
H.P. LINES TO DIGITAL GROUND

D1A	BLK
D1B	BRN
D1C	RED
D1D	ORG
D2A	YEL
D2B	GRN
D2C	BLU
D2D	VIO
D3A	WHT/BLK
D3B	WHT/BRN
D3C	WHT/RED
D3D	WHT/ORG
D4A	WHT/YEL
D4B	WHT/GRN
D4C	WHT/BLU
D4D	WHT/VIO
D5B	WHT/BLK/RED
D5C	WHT/BLK/ORG
D5D	WHT/BLK/YEL
D9D	WHT/ORN/VIO

NOTE 1
THE FOLLOWING TWO H.P. LINES MUST BE TIED TOGETHER AND ISOLATED

CTLB WHT/GRY
DFLGB WHT/RED/GRY

NOTE 2
INTERNAL SWITCH POSITIONS

S2
- 7 INVERT DFLGA
- 6 INVERT DFLGB
- 5 SELECT CTLA-2
- 4 SELECT CTLB-2
- 3 INVERT CTLA
- 2 INVERT CTLB
- 1 SELECT OPTIONAL FORMAT

S3
- 4 INVERT SGN 2
- 3 INVERT SGN 1
- 2 INVERT OVLD
- 1 INVERT DATA

GND → BLK
HOLD → CLR
DFLGA → RED

1 TO 555-67
2 DATA
9 CONTROLLER

P5 FEMALE SHELL MALE PIN
J5 MALE SHELL FEMALE PIN

APL

SL9-153
CROSS INDEX

DASH NO | NEXT ASSY | USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED REFER TO PROCESS STANDARDS 41001 AND 41002
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± ANGLES ±
3 PLACE DECIMAL ±
2 PLACE DECIMAL ±

UNLESS OTHERWISE SPECIFIED
RESISTANCE VALUES ARE
OHMS ± % WATT
CAPACITANCE VALUES ARE IN
FARADS ± % VOLTS
DIODES ARE TYPE
TRANSISTORS ARE TYPE

DO NOT SCALE PRINT

MATERIAL
FINISH SPECS

DRAWN C. LEBLANC	C.L.	11-7-79
CHECKED		DATE
ENGINEER		DATE
ENGINEER		DATE
PROJECT ENGINEER		DATE
PROJECT APPROVAL	A. Cox	11/9/79

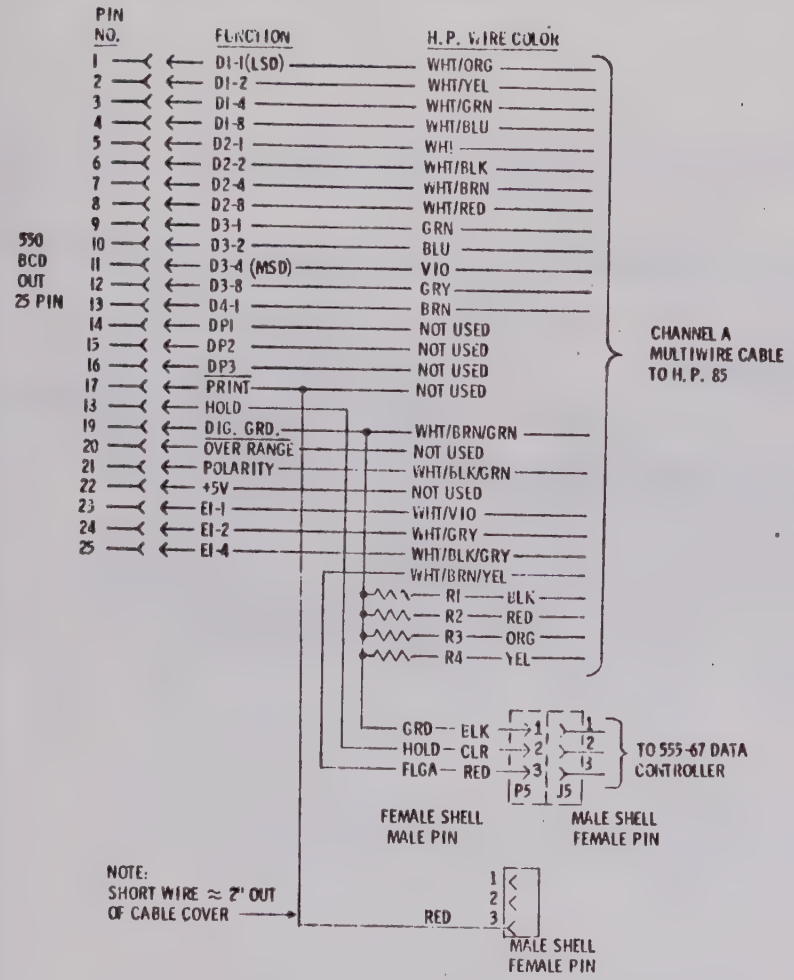
EDCO

Figure 16

WIRING DIAGRAM
550/555 TO H. P. 98035A BCD INTERFACE
(FOR USE WITH 9825, 9835 & 9845 CALCULATORS)

SIZE	CODE IDENT NO	TYPE		REV
C	25506		312866	E
SCALE			SHEET	

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	CHG'D PER DCN E-74	3-4-81	RJC



NOTES:

1. R1, R2, R3, R4 = 1K, 1/10 WATT.
2. SHIELD & DRAIN OF H.P. CABLE MUST NOT BE TOUCHING ANYTHING.
3. ALL UNUSED WIRES MUST BE LEFT UNCONNECTED.
4. INTERFACE SWITCH POSITIONS ARE AT FACTORY SETTINGS.
5. THE INTERFACE MUST BE USED WITH AN H.P. 82936A ROM DRAWER AND AN H.P. 00035-15003 I/O ROM.

TYPICAL PROGRAM COMMANDS

```
100 CONTROL 3, 3; 4, 1, 0, 2, 1(*)
110 ENTER 3; A
120 WAIT 100
130 A = A*-1
140 A = A*.00001
150 IF A< .00016 THEN 170
160 BEEP @ DISP "OVERRANGE"
170 E(I) = A/K (I)
```

(*) MAKE THE 1 AN 8 IF THE 555-67A CONTROLLER IS USED.

AFTER STEP 140, A IS THE ABSOLUTE CURRENT IN AMPERES.

APL

DRAWN	N. SUDAK		12/11/80	EG&G	Figure 17
CHECKED	R. SHINER	RJC	12/11/80		WIRING DIAGRAM 550/555 TO H.P. 82941A BCD INTERFACE FOR USE WITH H.P. 85 COMPUTER
DESIGNER	R. CAPO	RC	12/11/80		
ENGINEER	R. CAPO	RC	12/14/80		
PROJECT ENGINEER	R. WAT				
PROJECT APPROVAL			DATE	SIZE: C	CODE IDENT NO: 25506
				TYPE:	314548
				REV: A	
				SCALE:	SHEET

SLO-153 CROSS INDEX

DASH NO | NEXT ASSY | USED ON — APPLICATION

UNLESS OTHERWISE SPECIFIED REFER TO PROCESS STANDARDS 41001 AND 41002. DIMENSIONS ARE IN INCHES. TOLERANCES ON FRACTIONS ± ——— ANGLES ± —. 3 PLACE DECIMAL ± ——. 2 PLACE DECIMAL ± ——.

UNLESS OTHERWISE SPECIFIED RESISTANCE VALUES ARE ——— OHMS ± —% —— WATT. CAPACITANCE VALUES ARE IN ——— FARADS ± —% —— VOLTS. DIODES ARE TYPE ———. TRANSISTORS ARE TYPE ———.

DO NOT SCALE PRINT

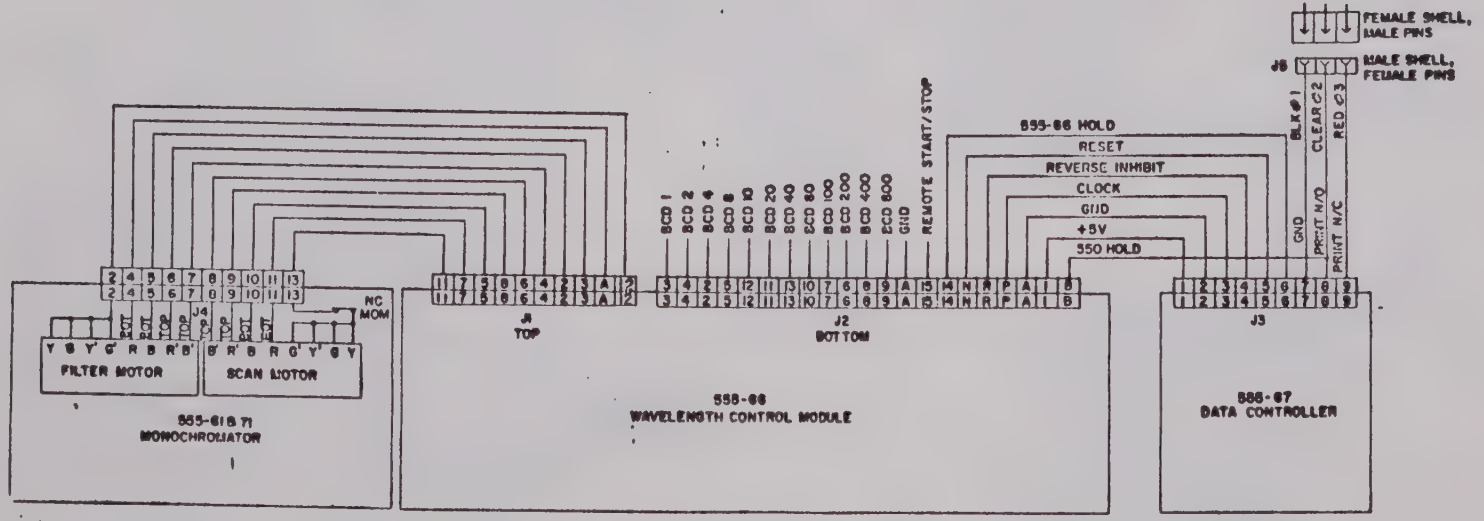
MATERIAL —#—

FINISH SPECS —#—

FORM NO 21003 STOCK NO 00021

NOTES:

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	REDRAWN, DCN A-317	10 13 11	
	B	J5 @ 2 WAS N/C, J5 @ 3 WAS N/O, ADDED MALE & FEMALE DESIGNATIONS TO J5 PER DCN C10.	8 26 79	
	C	ADDED SWITCH B TO J5-2, J5-3 AND J5-12 PER DCN C-604		
	D	ADDED "555-66" TO HOLD LEAD FROM J2-14 TO J3-9, ADDED "550 HOLD" LEAD FROM J2-8 TO J3-8 PER DCN B-226	5 10 80	



APL

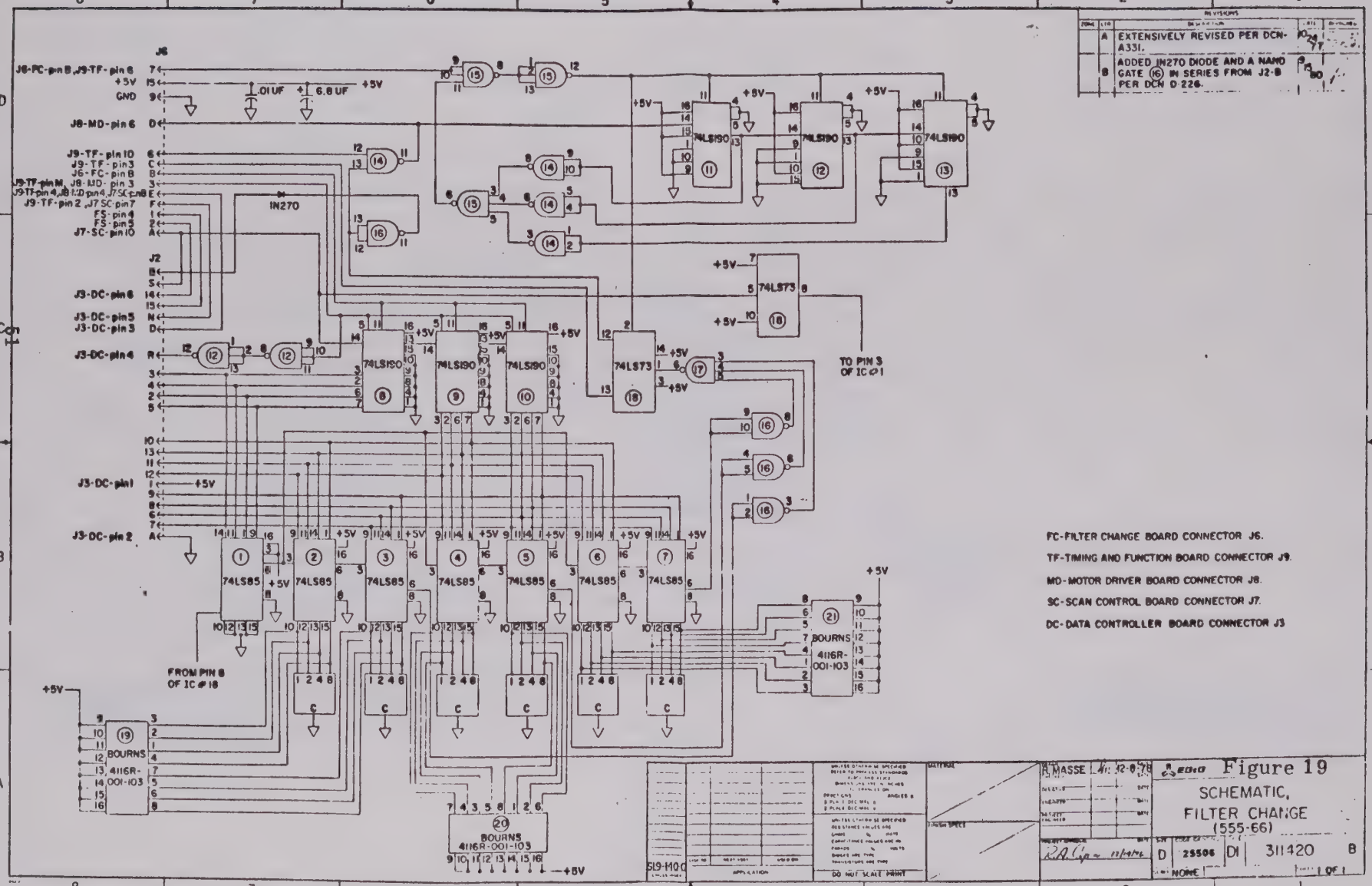
DO NOT SCALE PRINT

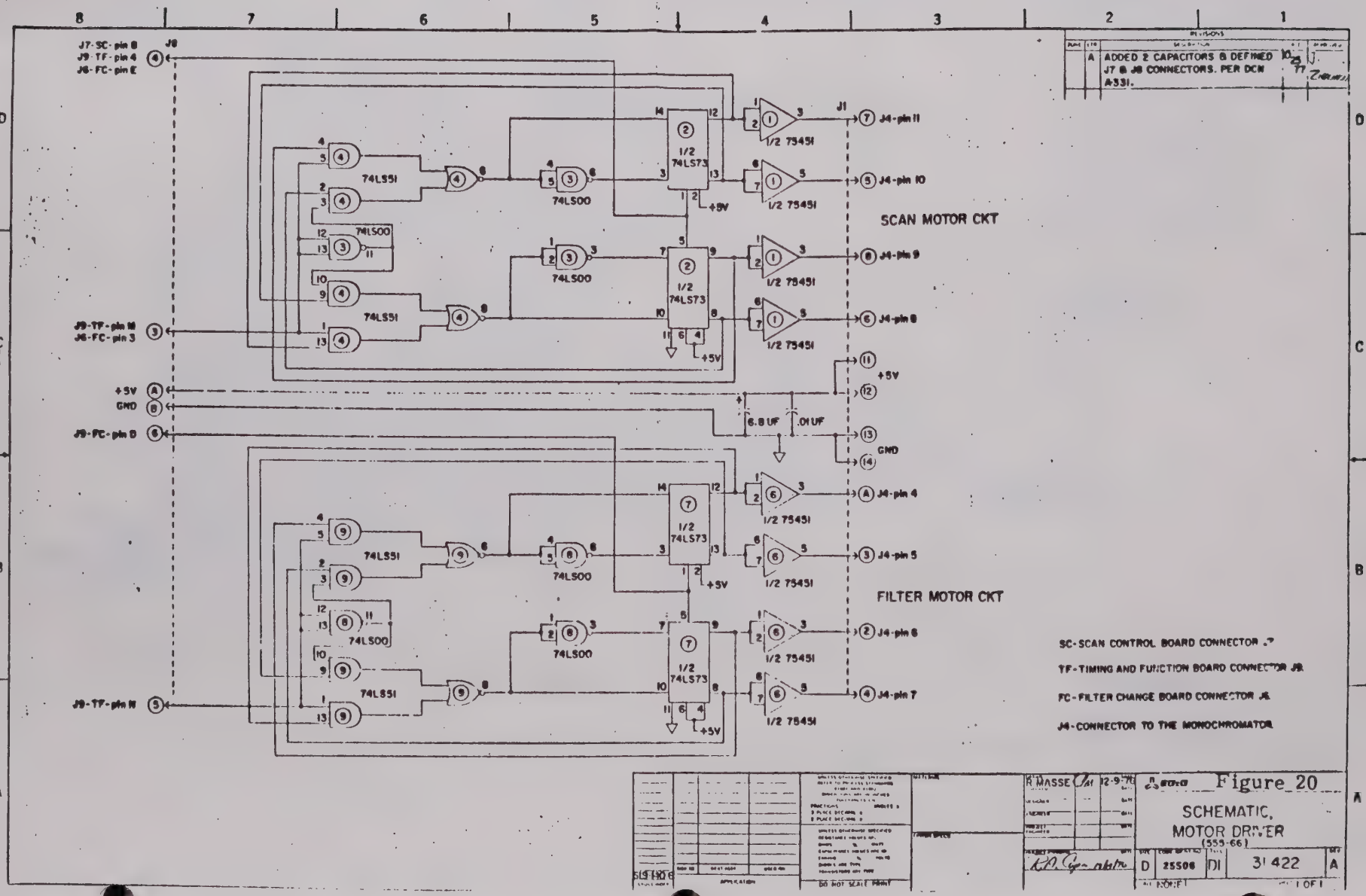
Figure 18

555 SYSTEM INTERCONNECTIONS

SIZE	CODE IDENT NO.	DWG NO.	REV
D	29506	311079	

SCALE NONE SHEET 1 OF 1


REVISIONS
A EXTENSIVELY REVISED PER DCN-A331.
B ADDED IN270 DIODE AND A NAND GATE (16) IN SERIES FROM J2-B PER DCN D-226.
J6
J8-FC-pin B, J9-TF-pin 6
+5V
GND
.01 UF
6.8 UF
J8-MD-pin 6
J9-TF-pin 10
J9-TF-pin 3
J6-FC-pin B
J8-MD-pin 3
J9-TF-pin 4, J8-MD-pin 4, J7-SC-pin B
J9-TF-pin 2, J7-SC-pin 7
FS-pin 4
FS-pin 3
J7-SC-pin 10
IN270
J2
J3-DC-pin 6
J3-DC-pin 5
J3-DC-pin 3
J3-DC-pin 4
J3-DC-pin 1
J3-DC-pin 2
74LS190
74LS373
74LS85
TO PIN 3 OF IC #1
FROM PIN 8 OF IC #18
BOURNS 4116R-001-103
FC-FILTER CHANGE BOARD CONNECTOR J6.
TF-TIMING AND FUNCTION BOARD CONNECTOR J9.
MD-MOTOR DRIVER BOARD CONNECTOR J8.
SC-SCAN CONTROL BOARD CONNECTOR J7.
DC-DATA CONTROLLER BOARD CONNECTOR J3
519-1100
DO NOT SCALE PRINT
R. MASSE 4-12-78
Figure 19
SCHEMATIC, FILTER CHANGE (555-66)
D 25505 DI 311420 B
NONE



REVISIONS			
A	ADDED 2 CAPACITORS & DEFINED J7 & J8 CONNECTORS. PER DCN A-331.	10-3-77	J. Zarnoch

R MASSE 12-9-70

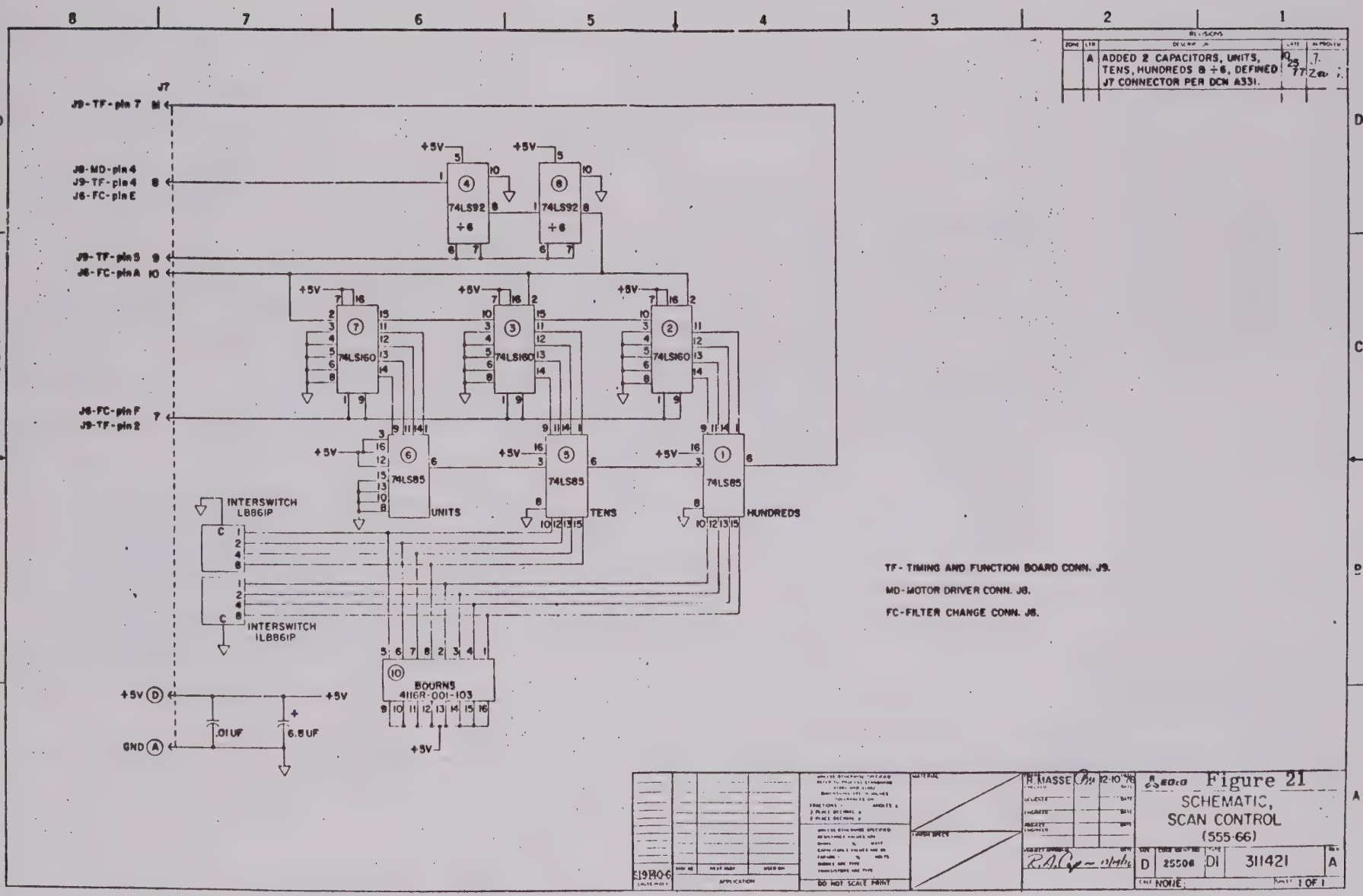
Figure 20

SCHEMATIC, MOTOR DRIVER (555-66)

SIZE	CODE IDENT NO.	TYPE	DRAWING NO.	REV
D	25506	DI	31 422	A

SCALE NONE SHEET 1 OF 1

DO NOT SCALE PRINT



TF - TIMING AND FUNCTION BOARD CONN. J9.

MD - MOTOR DRIVER CONN. J8.

FC - FILTER CHANGE CONN. J6.

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED
	A	ADDED 2 CAPACITORS, UNITS, TENS, HUNDREDS @ ÷6, DEFINED J7 CONNECTOR PER DCN A331.	10-23-77	J. Zea

Figure 21
SCHEMATIC,
SCAN CONTROL
(555-66)

SIZE	CODE IDENT NO.	TYPE	DWG NO.	REV
D	25506	DI	311421	A

SCALE NONE SHEET 1 OF 1

R. MASSE 12-10-76

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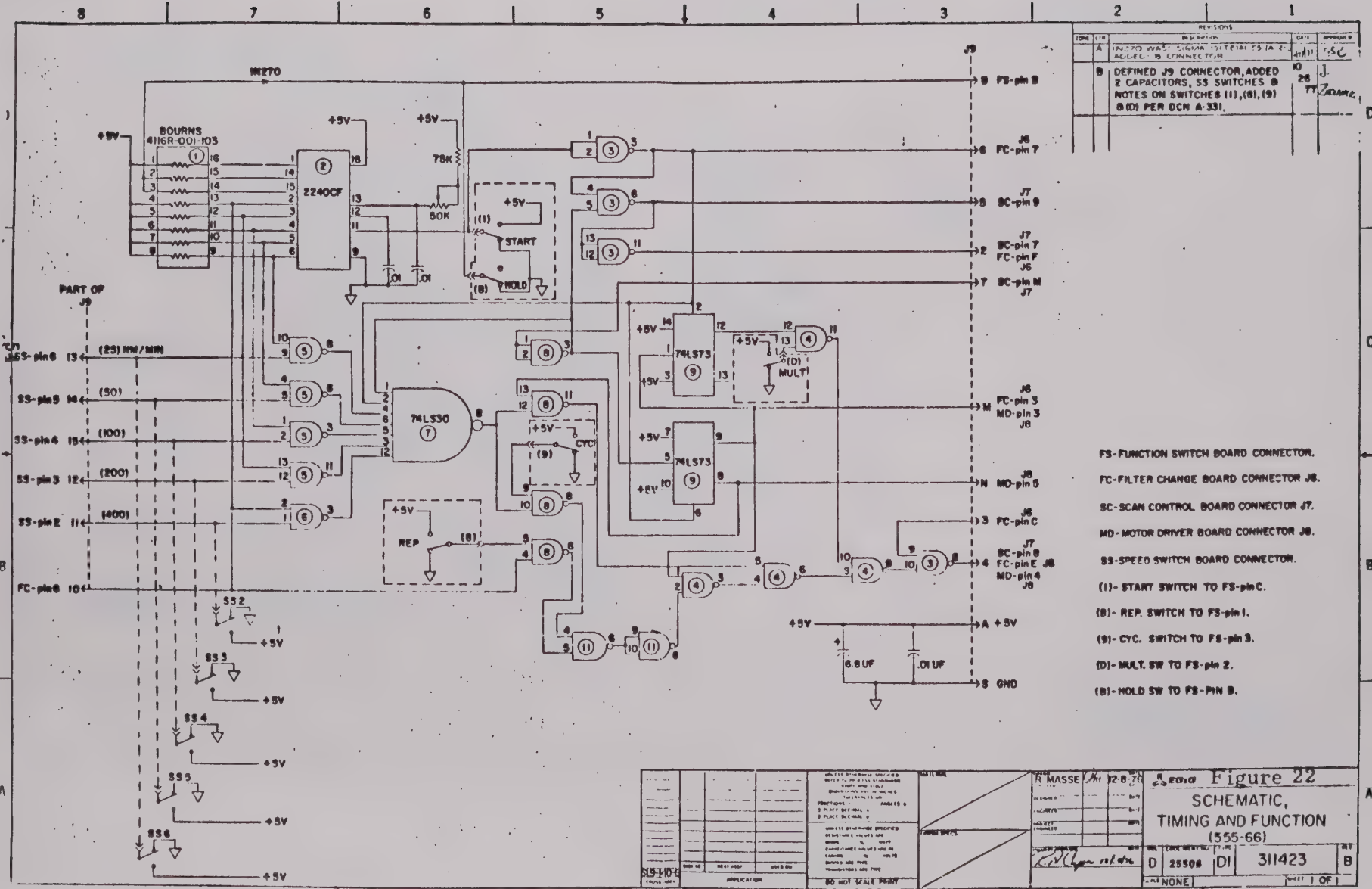
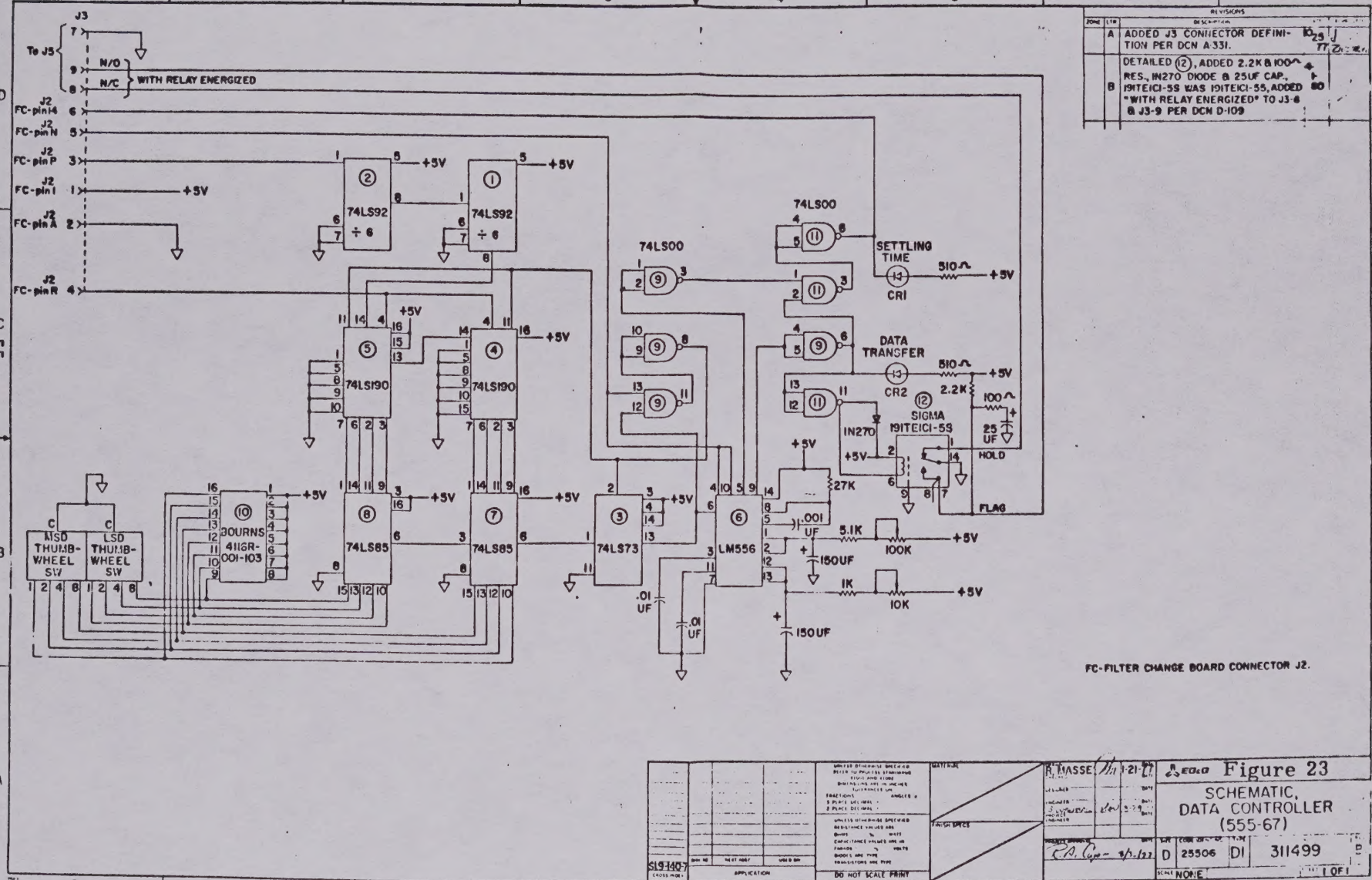
J53 -


REVISIONS
A IN270 WAS: SIGMA INITIAL RS IA 2-ADDED J9 CONNECTOR
B DEFINED J9 CONNECTOR, ADDED 2 CAPACITORS, SS SWITCHES & NOTES ON SWITCHES (1),(8),(9) & (D) PER DCN A-331.
IN270
BOURNS 4116R-001-103
2240CF
74LS30
74LS73
74LS73
+5V
78K
50K
.01
.01
START
HOLD
MULT
CYC
REP
PART OF J9
SS-pin6 (25) MM/MIN
SS-pin5 (50)
SS-pin4 (100)
SS-pin3 (200)
SS-pin2 (400)
FC-pin6
SS2
SS3
SS4
SS5
SS6
6.8 UF
.01 UF
9 FS-pin B
6 FC-pin 7
8 SC-pin 9
2 SC-pin 7 FC-pin F J6
7 SC-pin M J7
M FC-pin 3 MD-pin 3 J8
N MD-pin 5 J8
3 FC-pin C J6
4 SC-pin 8 FC-pin E J6 MD-pin 4 J8
A +5V
5 GND
FS-FUNCTION SWITCH BOARD CONNECTOR.
FC-FILTER CHANGE BOARD CONNECTOR J6.
SC-SCAN CONTROL BOARD CONNECTOR J7.
MD-MOTOR DRIVER BOARD CONNECTOR J8.
SS-SPEED SWITCH BOARD CONNECTOR.
(1)- START SWITCH TO FS-pin C.
(8)- REP. SWITCH TO FS-pin 1.
(9)- CYC. SWITCH TO FS-pin 3.
(D)- MULT. SW TO FS-pin 2.
(8)- HOLD SW TO FS-PIN 8.
DO NOT SCALE PRINT
R MASSE 12-8-76
Figure 22
SCHEMATIC, TIMING AND FUNCTION (555-66)
D 25506 DI 311423 B
NONE
SHEET 1 OF 1



ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED
	A	ADDED J3 CONNECTOR DEFINITION PER DCN A-331.	10-23-77	J
	B	DETAILED (12), ADDED 2.2K & 100Ω RES., IN270 DIODE & 25UF CAP., 191TEICI-5S WAS 191TEICI-55, ADDED "WITH RELAY ENERGIZED" TO J3-8 & J3-9 PER DCN D-109	1-20-80	

SLS-140-7

DO NOT SCALE PRINT

R. MASSE 1-21-77

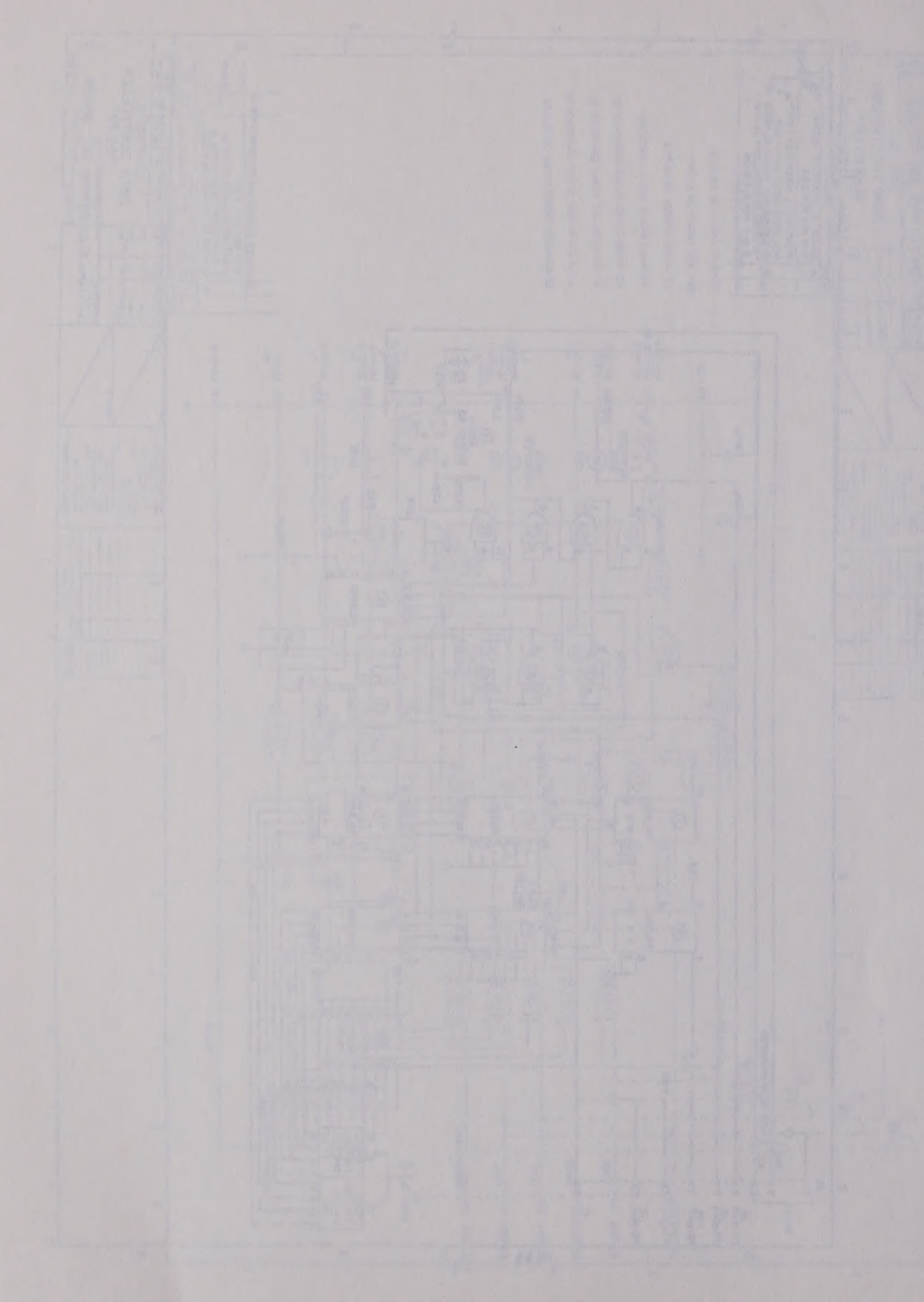
Figure 23

SCHEMATIC, DATA CONTROLLER (555-67)

SIZE	CODE IDENT NO.	TYPE	DWG NO.	REV
D	25506	DI	311499	B

SCALE NONE

1 OF 1



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